

# **ENGINEERING GRAPHICS**

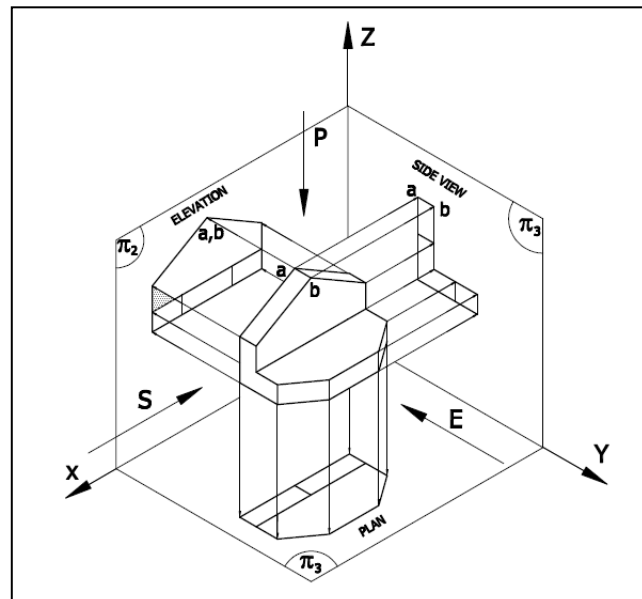
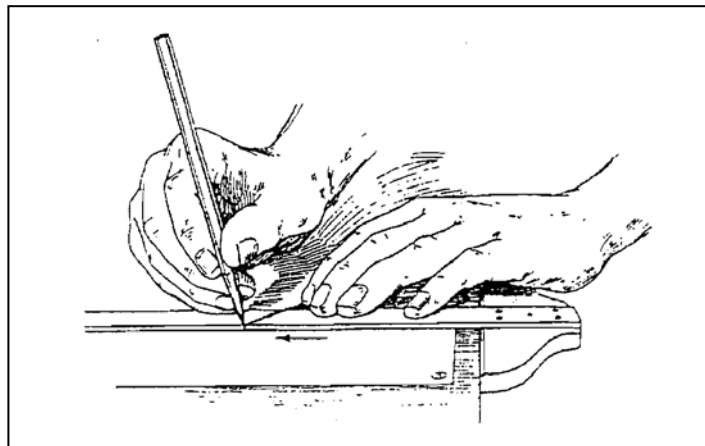
FOR

First Year Student

Specialized Scientific Programs (SSP)

Faculty of Engineering

Alexandria University



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# CHAPTER 1

## **Introduction to Engineering Graphics**

### 1. Introduction

The art of drawing is very old. Before man developed writing he tried to describe the things he saw by drawing them. Therefore drawing in fact is a language. Before trying to communicate with such a language, one should learn its basics and principles, just like any other language. Those basics of engineering drawing are lines, signs and symbols. Like any other language, it should be written in a readable way. One may notice that reading a drawing is more difficult than drawing it. The reason is that the reader has to imagine three dimensional objects from two dimensional drawing.

#### **The subject of engineering drawing requires three skills**

1. The ability to make drawing of any object representing both of their lines and features in a clear way to help the reader of those drawing to imagine what the objects look like.
2. Knowledge of some conventions which are used to save time and convey the exact information.
3. The ability to work very accurately with drawing instruments and convey the exact information.

In order to become an expert, it is necessary for the student to do a lot of training in geometrical constructions. This training will enable the student to use the instruments drawing effectively and, at the same time, let him know the necessary geometrical constructions needed in engineering drawing.

## 2. Drawing Instruments

To carry out any design in the drawing paper, drawing instruments such as T-square, Triangles (set squares), Scale, French curves, Pencils and compasses are necessary for the designer.

### 2.1 T-Square

T-square, Fig. 1, is a simple model that has been used for many decades. It usually made either of wood with plastic edges or totally of plastic. Metal T-square is also available but it is not recommended for the beginners. There are different lengths of the T-square, the best one for the beginners is about 90 cm.

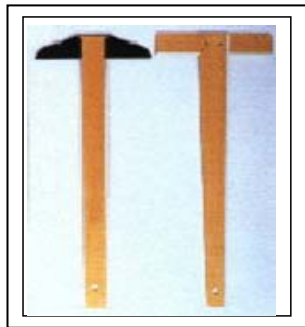


Fig. 1

### 2.2 Triangles

Triangles, Figures 1 and 2, are made of clear transparent plastic. The uncolored version of triangles is preferred for many drafters. For ordinary draft, 15-20 cm for 45° triangle and 25-30 cm for 30° -60° triangle are good sizes.

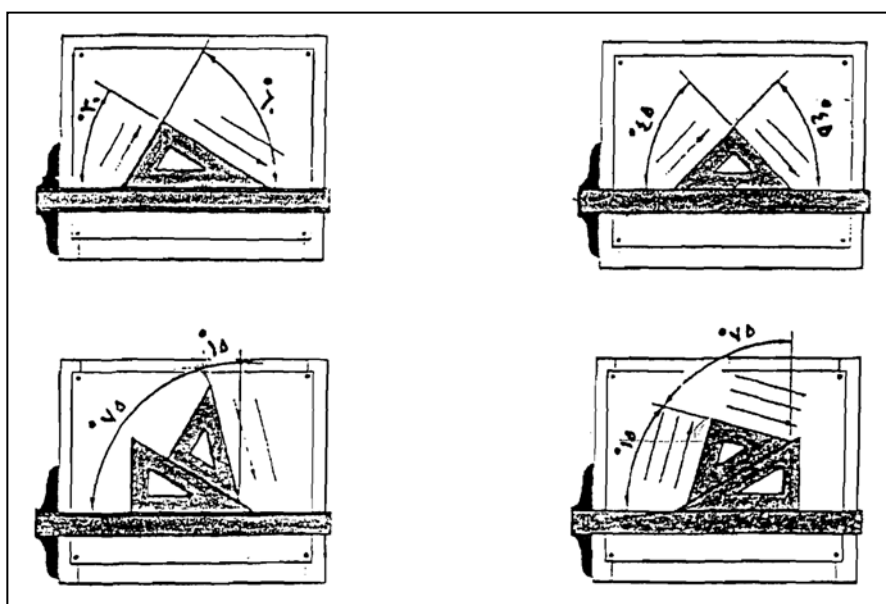


Fig. 2

## 2.3 Scales

It is common to enlarge or reduce the size of some parts of technical draft in order to zoom-in or zoom-out these parts. This is usually done using scale. Also, the scale is used to measure or draw the parts.

For our purpose, a transparent plastic scale with graded two edges is needed. One edge is graded in centimeters and millimeters. The other edge is graded in inches and 16 subdivisions of 1/16 length of inch. The recommended size of required scale is 30 cm or 12 inches.

## 2.4 French Curves

They are an irregular curved rulers used for drawing the curved lines other than circles and arcs, see figure 3. The forms of these curves are laid out in parts of conic sections and other geometric curves.

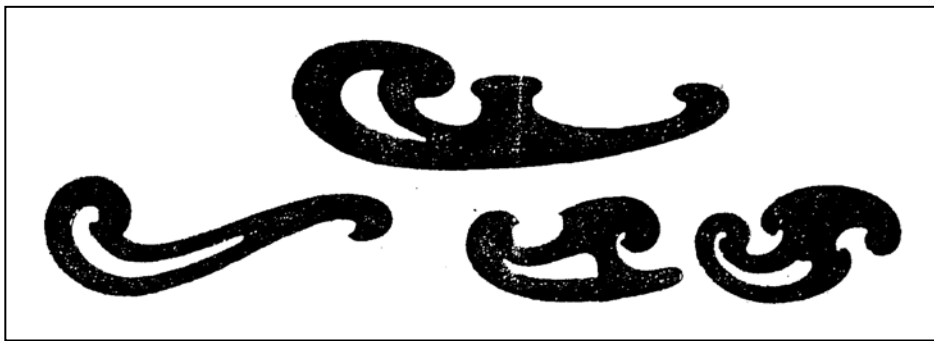


Fig. 3

## 2.5 Pencils

There are different types of pencils, some of them are ordinary and made of wood. There are semi-automatic or mechanical pencils, Fig. 4. The mechanical pencils are more convenient because they are fabricated with various types of line-weight (thickness of line) such as 0.3, 0.5, 0.7, 0.9 and 1 mm.

Drawing pencils are denoted by number of letters synthesized from H, B and HB grads. For example, H grade is used to draw light lines, B grade is used to draw heavy lines and HB is used for medium lines.



Fig. 4

## 2.6 Compasses Group

This group is used for drawing circles. At least a small compass, a large compass is needed for drawing various sizes of circles, see Fig.5. Also divider, Figure 6, with two metal fine pens is needed for transferring the measurements.

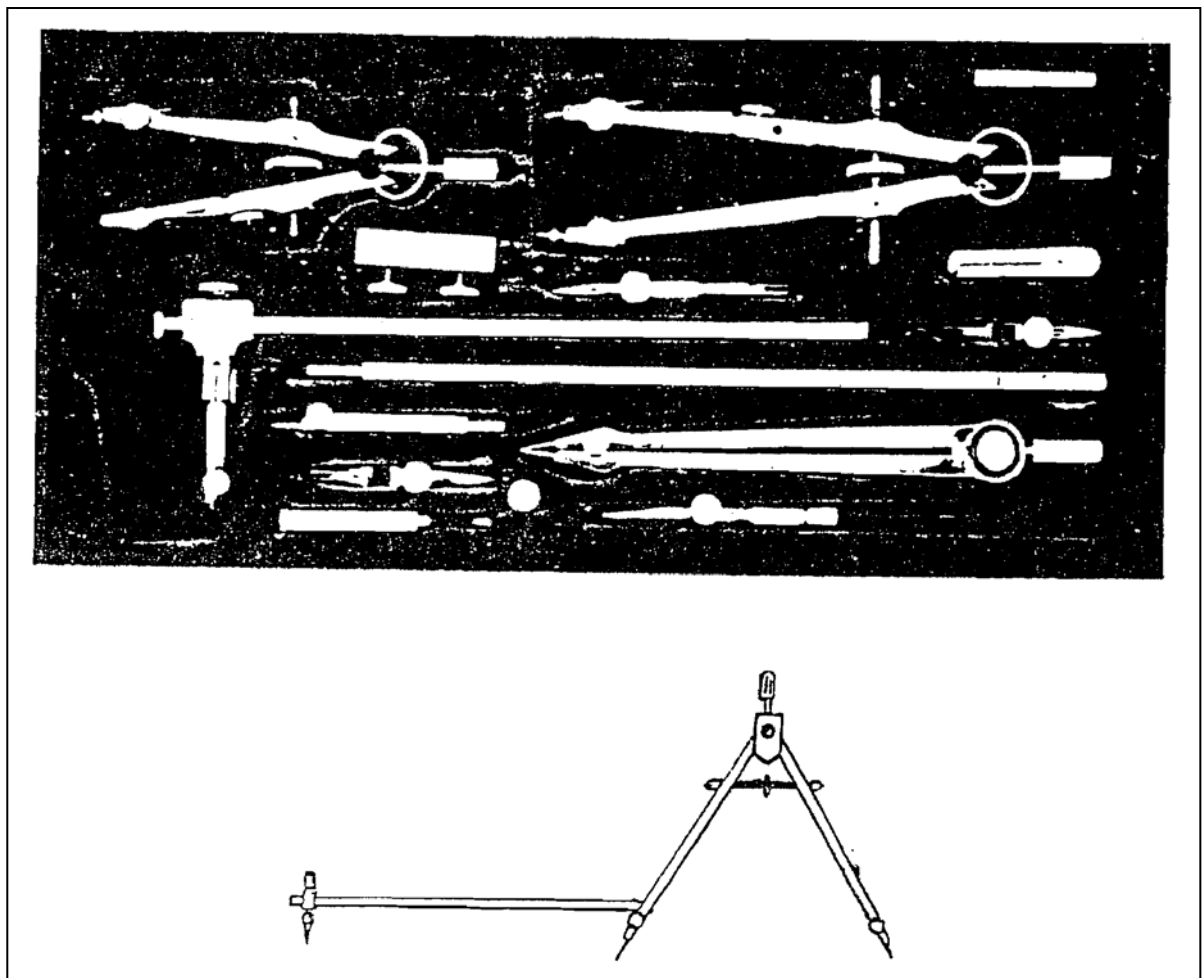


Fig. 5

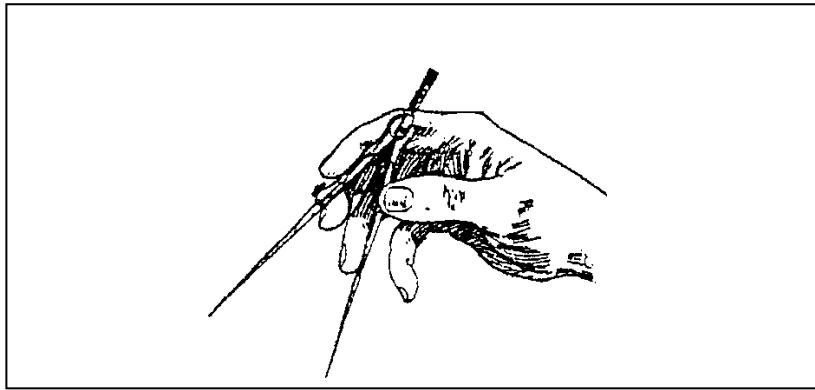


Fig. 6

## 2.7 Drawing Board

Drawing board is rectangular board made of rigid smooth wood. It has a perfect straight working edge at the left side.

## 2.8 Drawing paper

This paper should have a hard surface not easily grooved by the pencil and good erasing qualities. For the first year student, the required size of drawing paper is 50 x 70 cm.

## 2.9 Protractor

It is a graded tool used to measure angles, Fig. 7

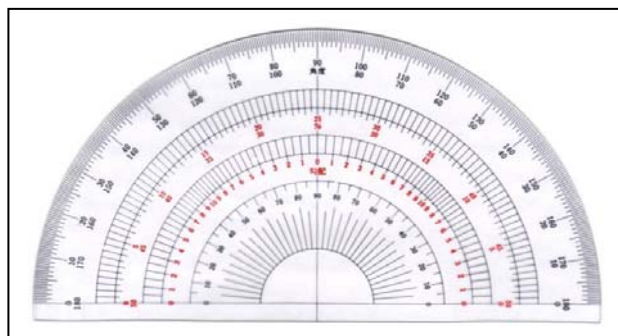


Fig. 7

## 2.10 Eraser and Scotch tape

Erase and Scotch tape are necessary accessories used for erasing the wrong lines and fixing the drawing paper

### 3. The use of Instruments

Before starting drawing, the board and instruments should be wiped with dust cloth. The instruments should be placed within easy reach, on the drawing table or on a special stand, which is located beside the drawing table.

The paper should be placed close to the left working edge of the drawing board. T-square is used to draw the horizontals. Also it is used as a horizontal guide for dragging triangles, see Figures 8 and 9.

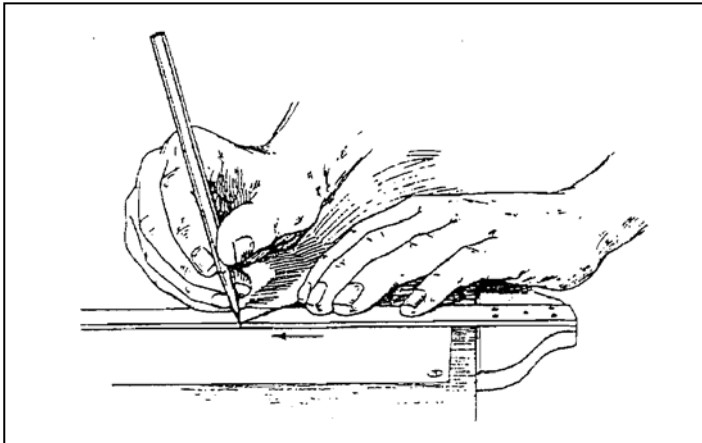


Fig. 8

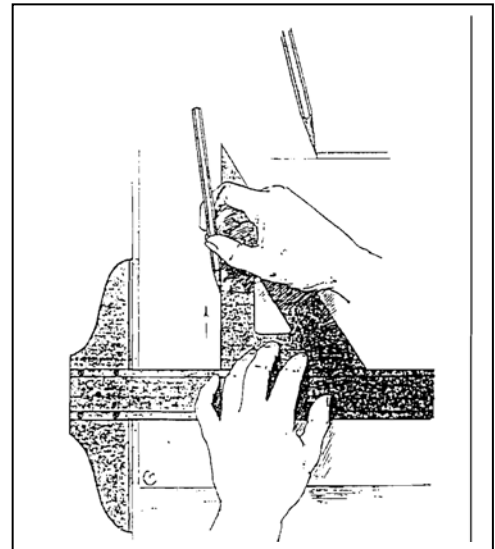


Fig. 9

Triangles are used to draw the vertical lines and some particular inclined lines 15, 30, 45, 60, 75 angles with the horizontal direction. Also they are used for drawing parallel lines, see Figures 10, 11 and 12.

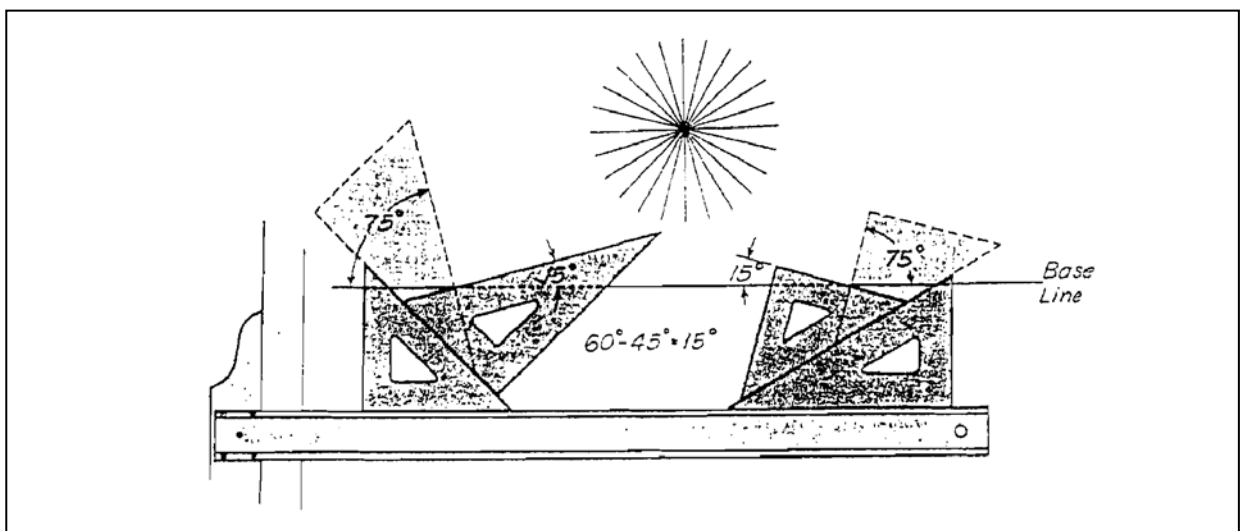


Fig. 10

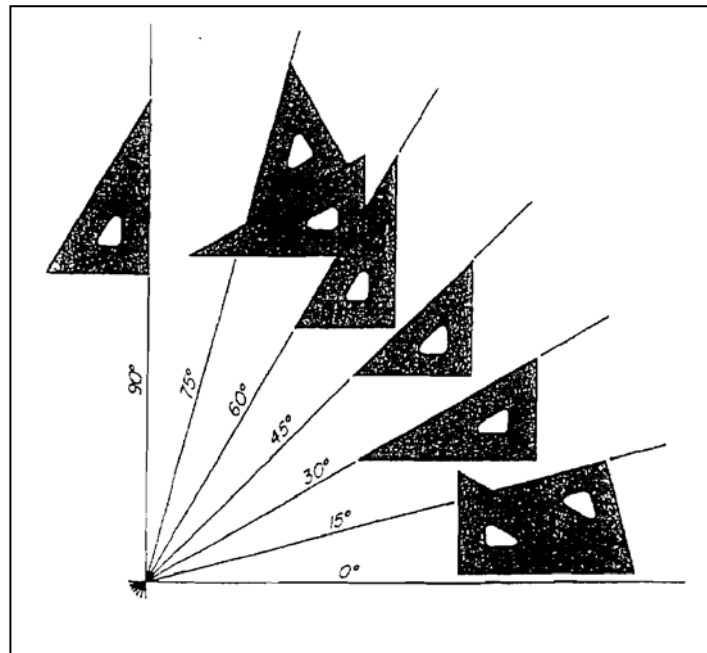


Fig. 11

Triangles are used to draw parallel lines as shown in Fig. 12 and 13.

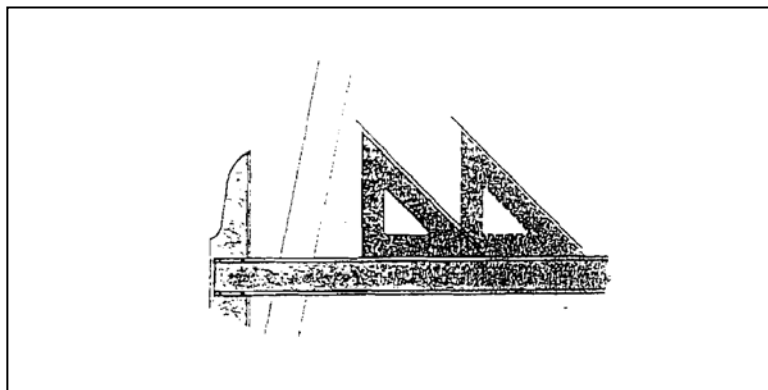


Fig. 12

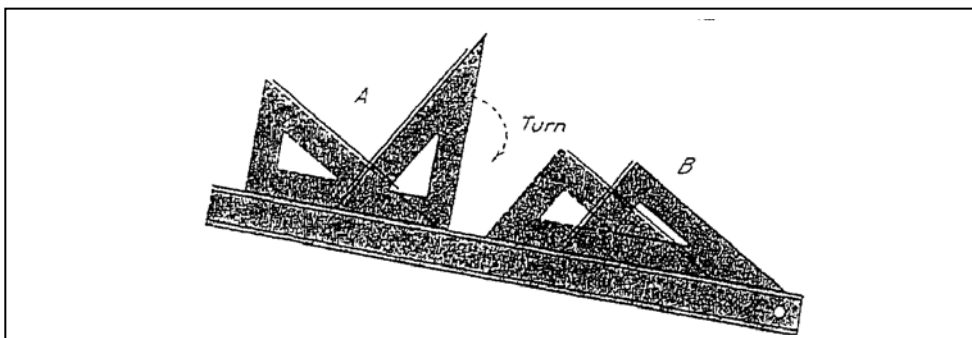






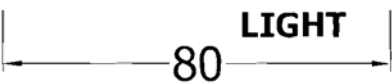


Fig. 13



#### 4. Alphabet of lines

Lines are the basis of drawing. There are many types of lines such as continuous, dashed, center, and cutting lines. Table 1 shows the most common types of lines used in the first year course.

Table 1: Types of lines

Grade of used pencil	Use	Line
(B)	Outline of part	<b>HEAVY</b> 
(H)	Hatching lines	<b>LIGHT</b> 
(HB)	Hidden Lines	<b>MEDIUM</b> 
(H)	Center lines	<b>LIGHT</b> 
(H)	Dimension and extension lines	 <b>LIGHT</b>
(B)	Cutting plane lines	<b>HEAVY</b> 
(H)	Break Lines	<b>LIGHT</b> 

## 5. Basic Dimensioning

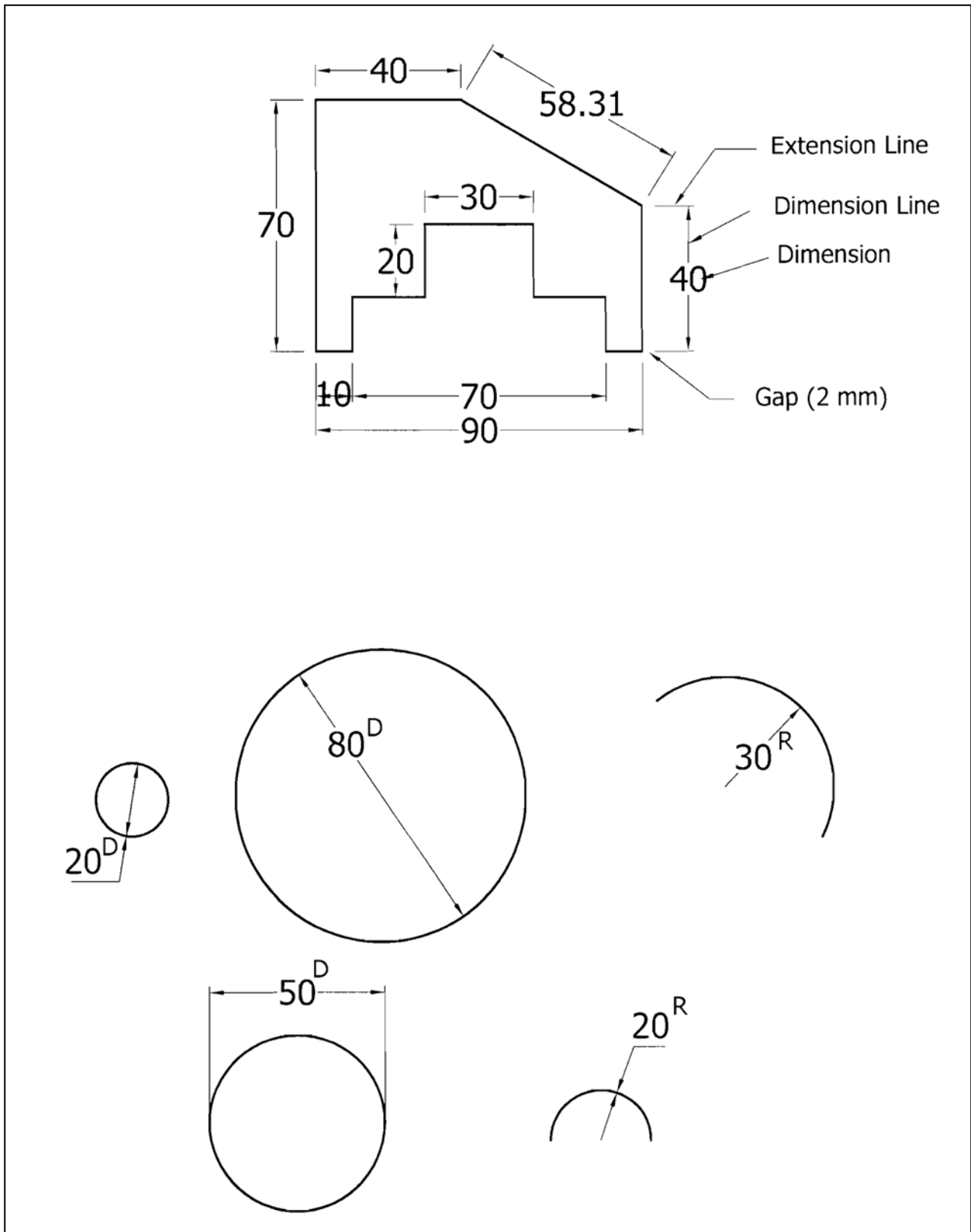


Fig. 14

# CHAPTER 2

## **Useful Geometrical Constructions**

### **Introduction**

The perfect draft is the main aim that we need in this section. The more precise measuring as well as detecting construction operations is important for you to get accurate and professional drawing. Generally, the drawing you obtain will be only as accurate as your skill makes it.

### **1 TO DIVIDE A LINE INTO ANY NUMBER OF EQUAL PARTS, e.g. SIX EQUAL PARTS**

- a- Let AB be the given line as shown in Fig. 15.
- b- Draw AC at an angle of approximately 30° to AB.
- c- With any convenient radius, set off from A six equal divisions along the line AC.
- d- Join 6 to B.
- e- With the aid of two set squares draw lines parallel to 6B from the other points.
- f- The parallel lines cut AB into six equal parts.

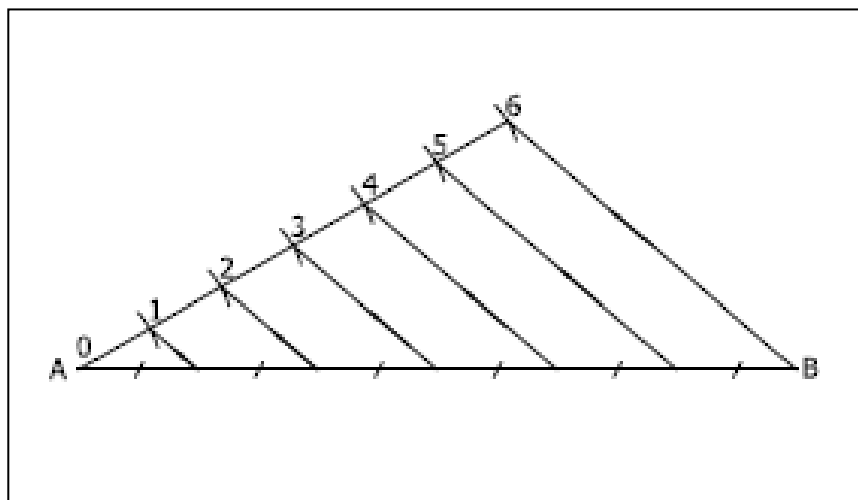


Fig. 15

## 2 To bisect a given line AB and to draw a perpendicular to it

- a- Let AB be the given line as shown in Fig. 16
- b- With center A and radius greater than half AB draw an arc.
- c- With center B and the same radius draw an arc intersecting the previous arc at C and D.
- d- Join C to D. The line CD is perpendicular to and also bisects AB.

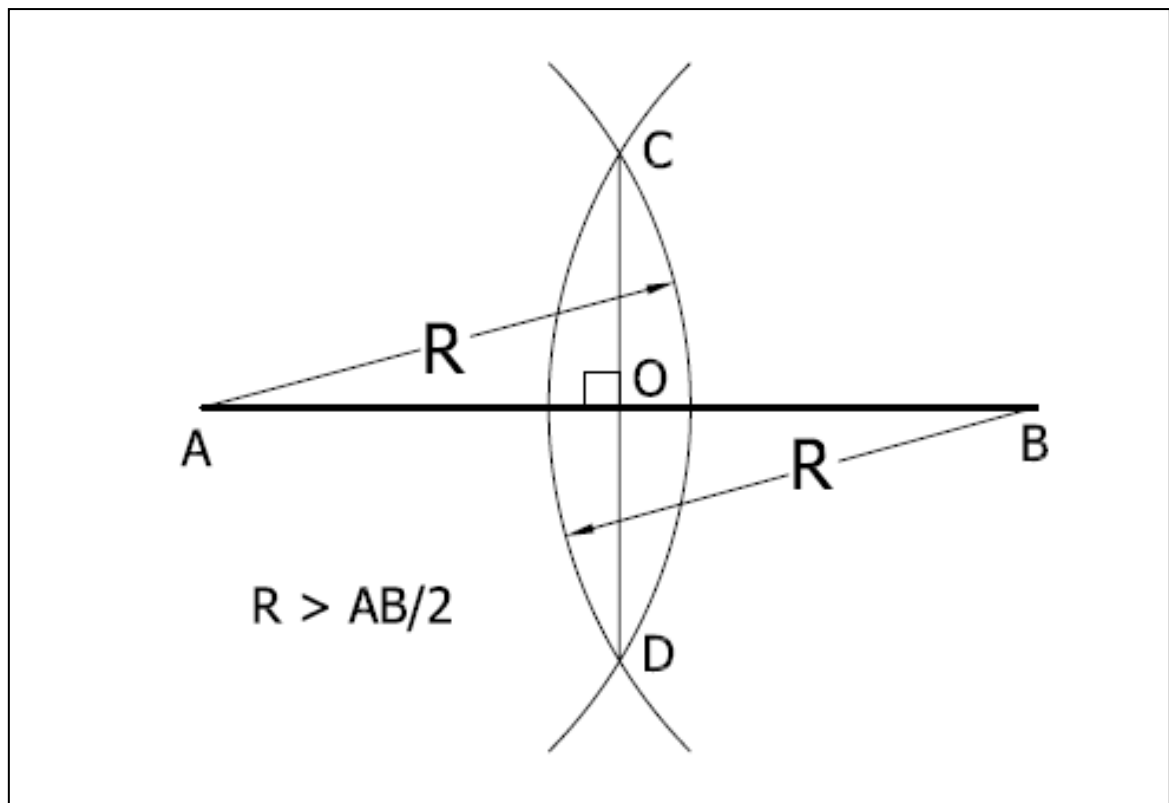


Fig. 16

### 3 To bisect a given angle ABC

- a- Let ABC be the given angle as shown in Fig.17.
- b- With center B and any radius R draw an arc ED.
- c- With centers E and D draw similar arcs to intersect at F.
- d- join BF.
- e- The required bisector of the angle ABC is BF.

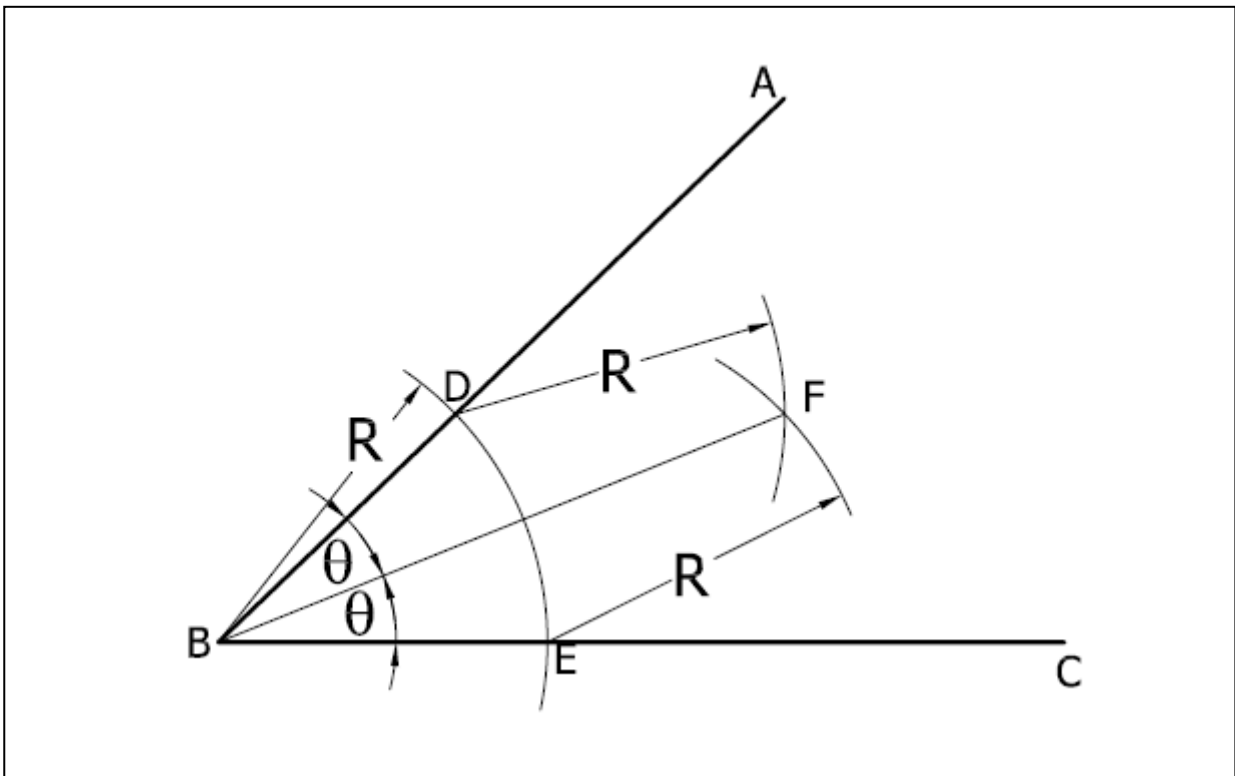


Fig. 17

#### 4 To draw a fillet arc, with radius $R$ , tangential to two straight lines

- a- Let  $L1$  and  $L2$  be the given lines and  $R$  a given fillet radius as shown in Fig. 18.
- b- Draw line  $L3$  Parallel to  $L1$  and distance  $R$  from it.
- c- Draw line  $L4$  Parallel to  $L2$  and distance  $R$  from it.
- d- The intersection of  $L3$  and  $L4$  gives the center " $O$ " for the fillet arc.
- e- Draw line  $OT1$  perpendicular to  $L1$ .
- f- Draw line  $OT2$  perpendicular to  $L2$ .
- g- With center  $O$  and radius  $R$  draw a fillet between the two tangent points  $T1$  and  $T2$ .

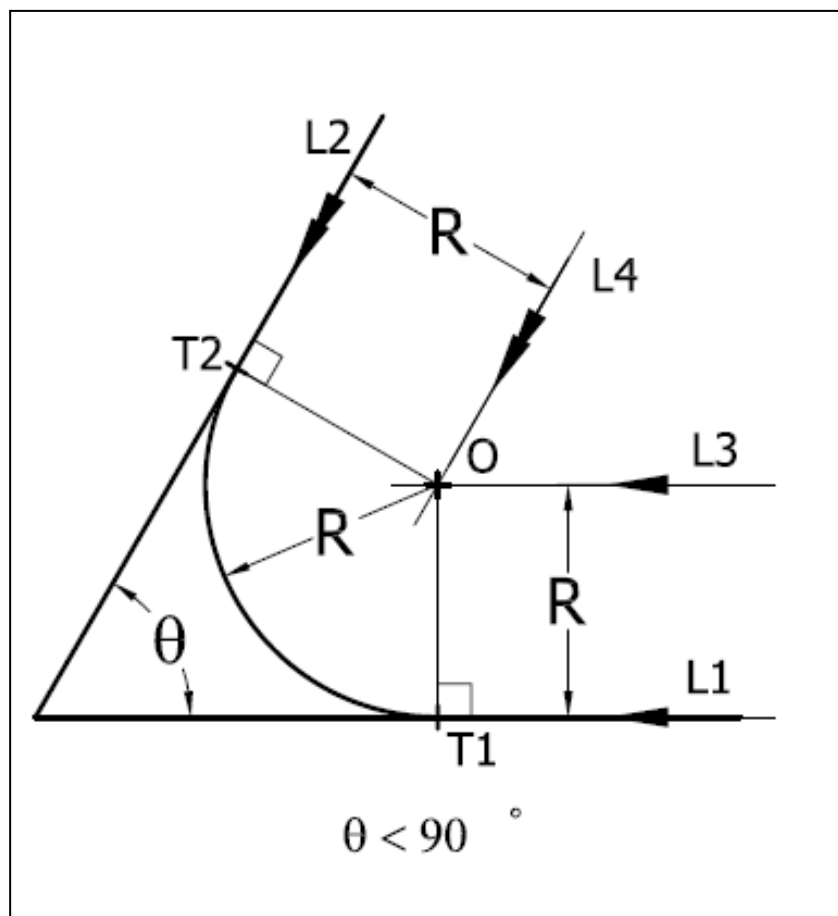


Fig. 18-a

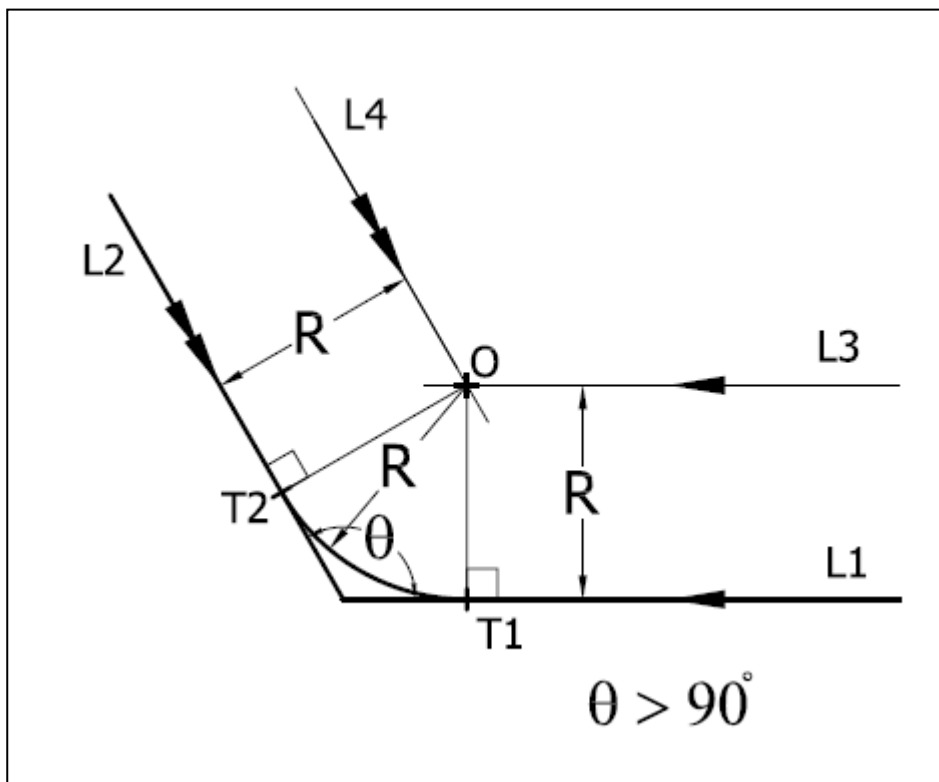


Fig. 18-b

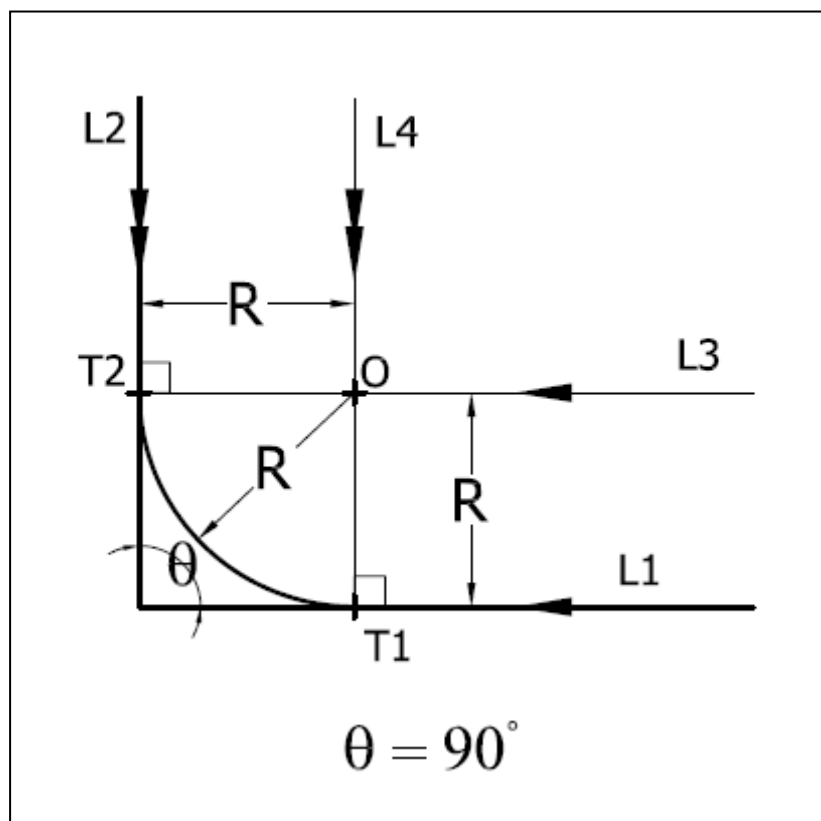


Fig. 18-c

## 5 To draw a tangent to a circle from a given point outside the circle

- a- Let  $O$  be the center of the given circle and  $P$  the given point, see Fig. 19.
- b- Join  $O$  to  $P$ .
- c- Bisect  $OP$  at point  $A$ .
- d- With  $A$  as center and  $AO$  as radius, draw a semicircle intersecting the given circle at the tangent point  $T$ .
- e- Draw a line  $PT$  which is the required tangent.

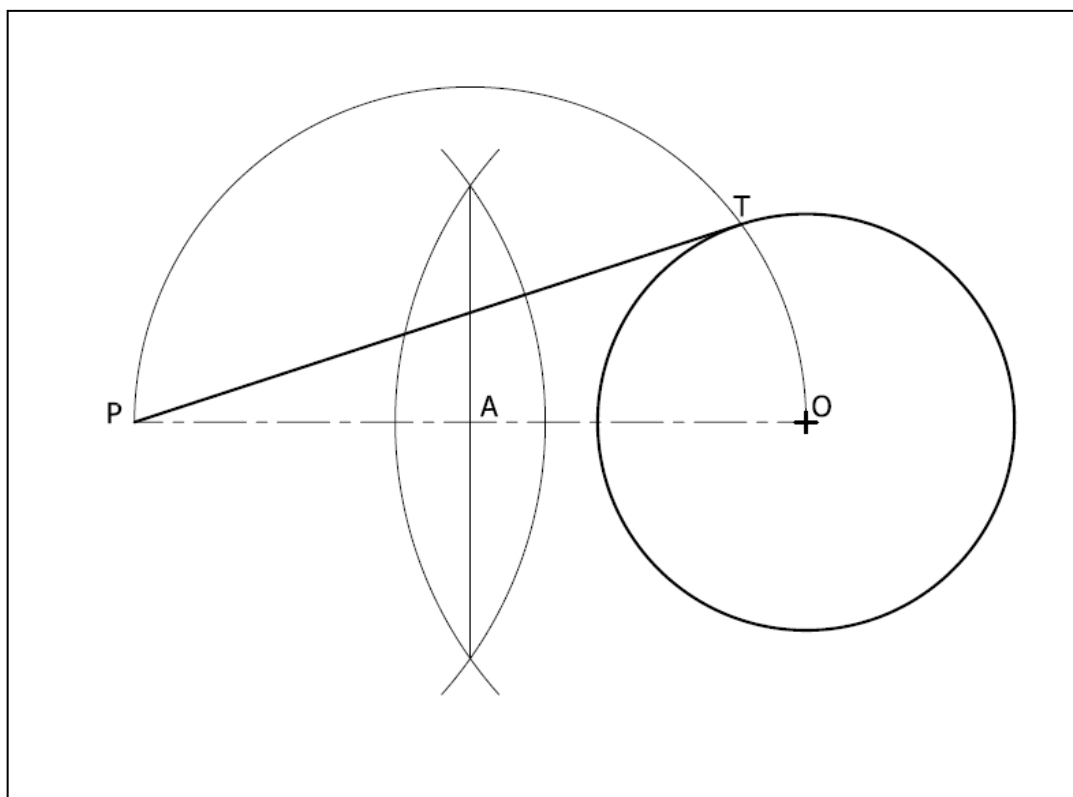


Fig. 19



## 6 To draw an external tangent to two given circles (open belt)

- a- Let A and B the centers of the given circles of radii  $R_1$  and  $R_2$  respectively, see Fig. 20.
- b- Join A to B and bisect AB at point O.
- c- With O as center and OA as radius, draw a semicircle.
- d- With center A and radius  $R_1 - R_2$ , draw a circle intersecting the semicircle at point C.
- e- Join AC and extend it to intersect the larger of the given circles at D
- f- Join CB. With CB as radius and D as center plot point E on the small circle.
- g- Join DE to give the required tangent.

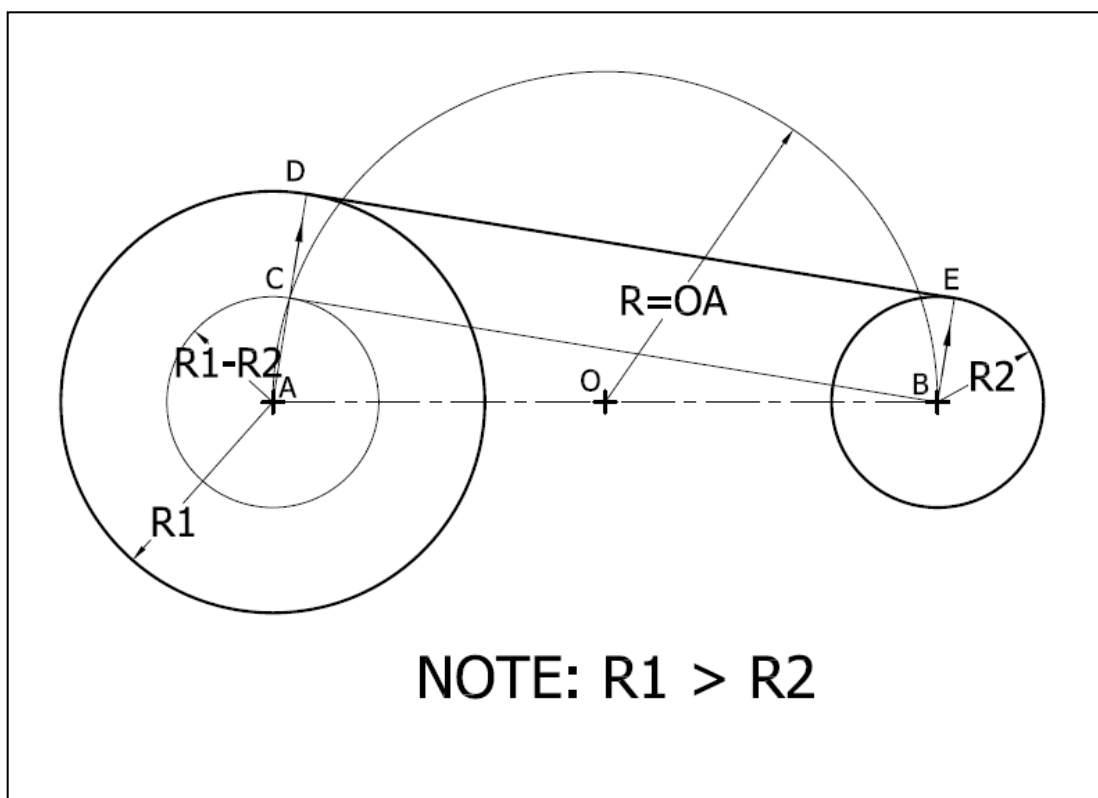


Fig. 20

## 7 To draw an internal tangent to two given circles (crossed belt)

- a- Let A and B the centers of the given circles of radii  $R_1$  and  $R_2$  respectively, see Fig. 21.
- b- Join A to B and bisect AB at point O.
- c- With O as center and OA as radius, draw a semicircle.
- d- With center A and radius  $R_1 + R_2$ , draw a circle intersecting the semicircle at point C.
- e- Join AC to intersect the larger of the given circles at D
- f- Join CB. With CB as radius and D as center mark point E on the small circle.
- g- Join DE to give the required tangent.

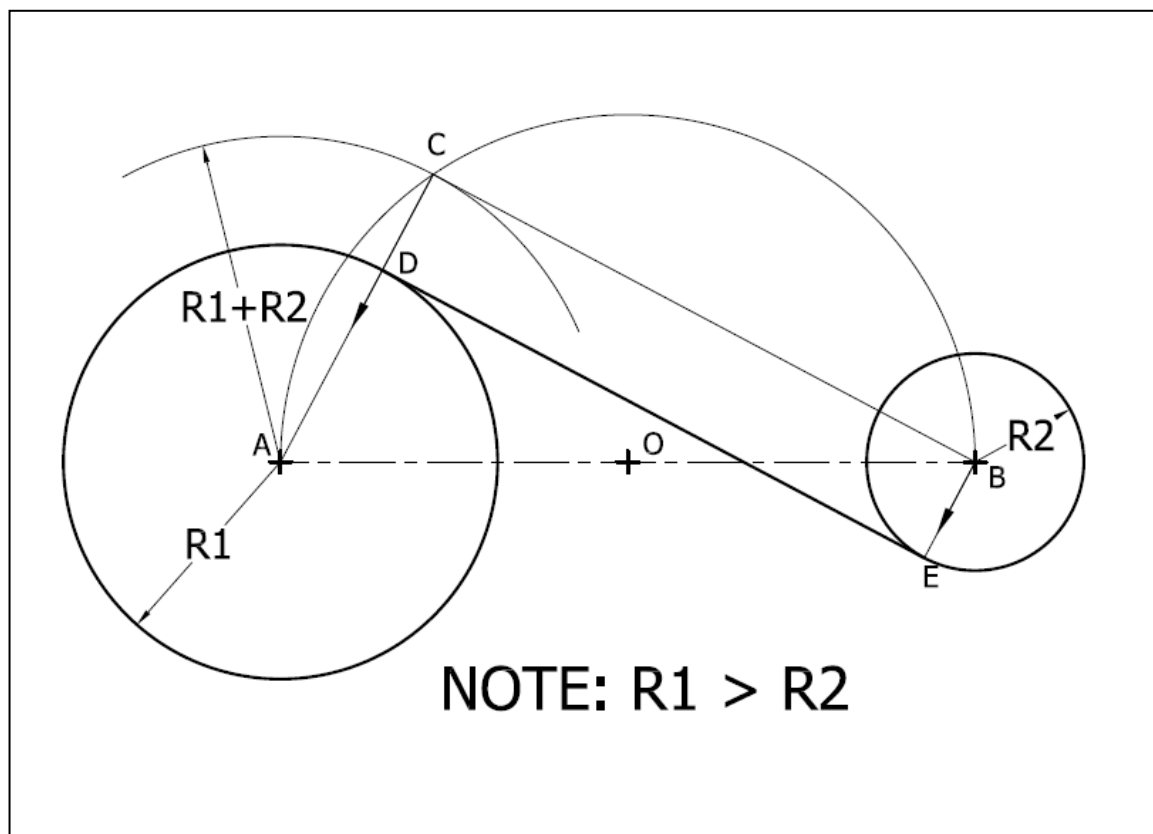


Fig. 21

## 8 To draw a fillet arc tangential to a line and a circle (case 1)

- a- Let  $L1$  be the given line and  $A$  the center of the given circle of radius  $R1$ . Let  $R2$  be the radius of the required fillet arc, see Fig. 22.
- b- With center  $A$  and radius  $R1+R2$ , draw a construction arc.
- c- On the side of the required fillet center, draw a construction line  $L2$  parallel to the given line  $L1$  and distance  $R2$  from it to intersect the construction arc at  $O$ .
- d- Join  $A$  to  $O$  to intersect the given circle at the tangent point  $T1$ .
- e- Draw line  $OT2$  perpendicular to the given line  $L1$  to get the tangent point  $T2$ .
- f- With  $R2$  as radius and  $O$  as center draw the required fillet between  $T1$  and  $T2$ .

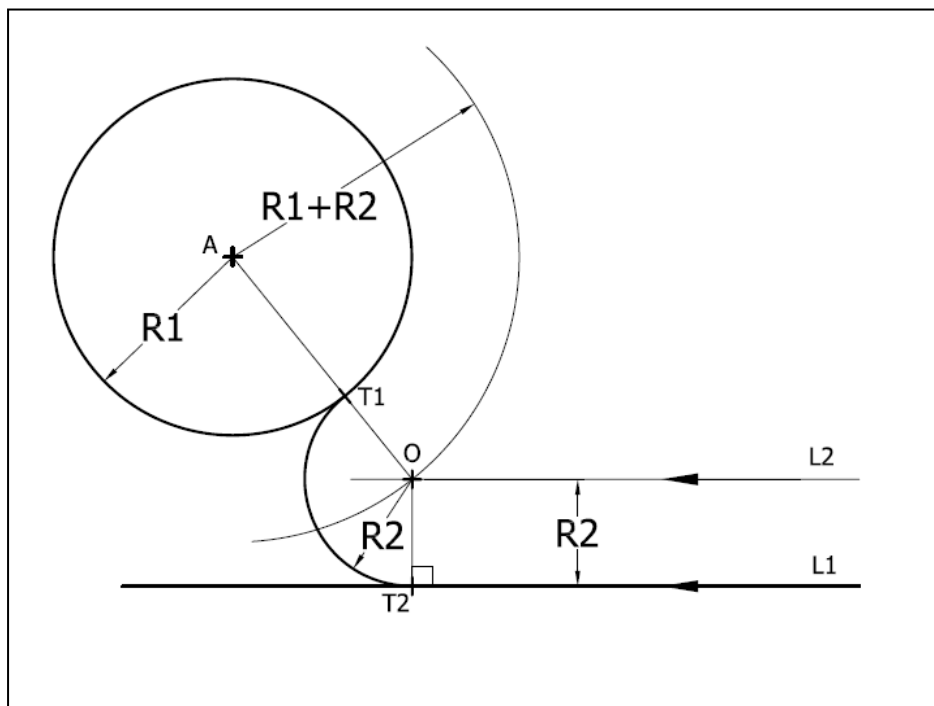


Fig. 22

## 9 To draw a fillet arc tangential to a line and a circle (case 2)

- a- Let  $L1$  be the given line and  $A$  the center of the given circle of radius  $R1$ .  
Let  $R2$  be the radius of the required fillet arc, see Fig. 23.
- b- With center  $A$  and radius  $R2-R1$ , draw a construction arc.
- c- On the side of the required fillet center, draw a construction line  $L2$  parallel to the given line  $L1$  and distance  $R2$  from it to intersect the construction arc at  $O$ .
- d- Join  $O$  to  $A$  and extend it to intersect the given circle at the tangent point  $T1$ .
- e- draw line  $OT2$  perpendicular to the given line  $L1$  to get the tangent point  $T2$ .
- f- With  $R2$  as radius and  $O$  as center draw the required fillet between  $T1$  and  $T2$ .

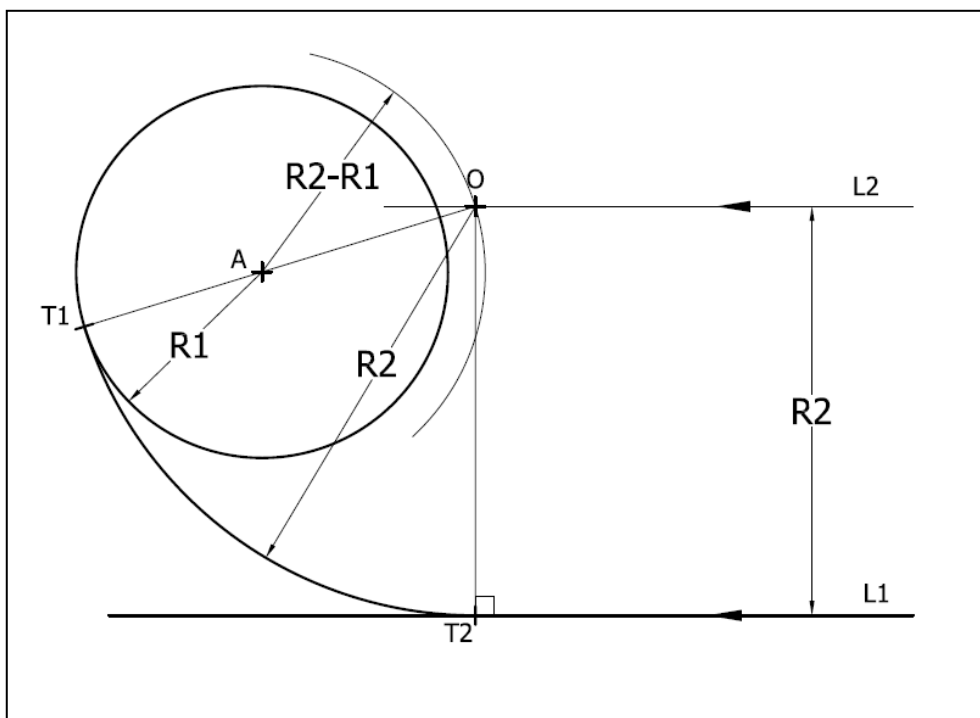


Fig. 23

## 10 To draw a fillet arc tangential to two circles (internally)

- a- Let  $R_1$  and  $R_2$  be the radii of the given circles and  $R$  be the radius of the required circle, see Fig. 24.
- b- With center A and radius  $R+R_1$ , draw an arc.
- c- With center B and radius  $R+R_2$ , draw an arc to intersect the previous arc at O.
- d- Join O to A to intersect the given circle at the tangent point T1.
- d- Join O to B to intersect the other given circle at the tangent point T2.
- e- With  $R$  as radius and O as center draw the required fillet between T1 and T2.

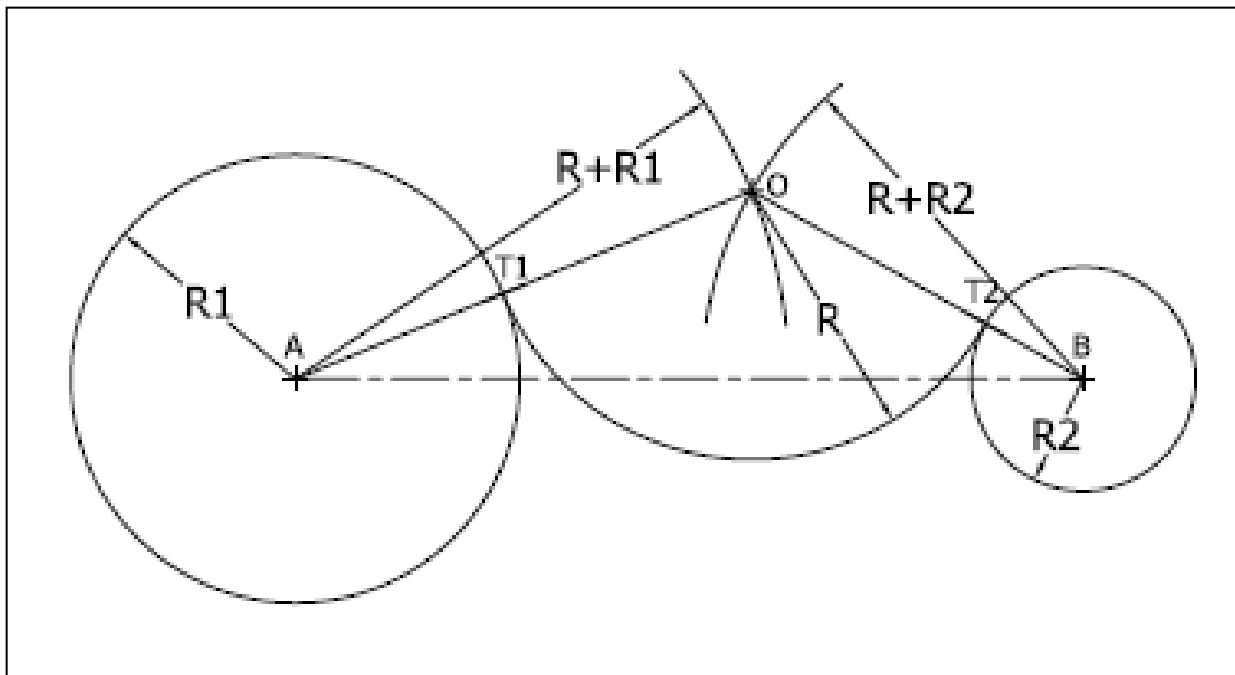


Fig. 24

## 11 To draw a fillet arc tangential to two circles (externally)

- a- Let  $R_1$  and  $R_2$  be the radii of the given circles and  $R$  be the radius of the required circle, see Fig. 25.
- b- With center A and radius  $R-R_1$ , draw an arc.
- c- With center B and radius  $R-R_2$ , draw an arc to intersect the previous arc at O.
- d- Join O to A to intersect the given circle at the tangent point T1.
- d- Join O to B to intersect the other given circle at the tangent point T2.
- e- With  $R$  as radius and O as center draw the required fillet between T1 and T2.

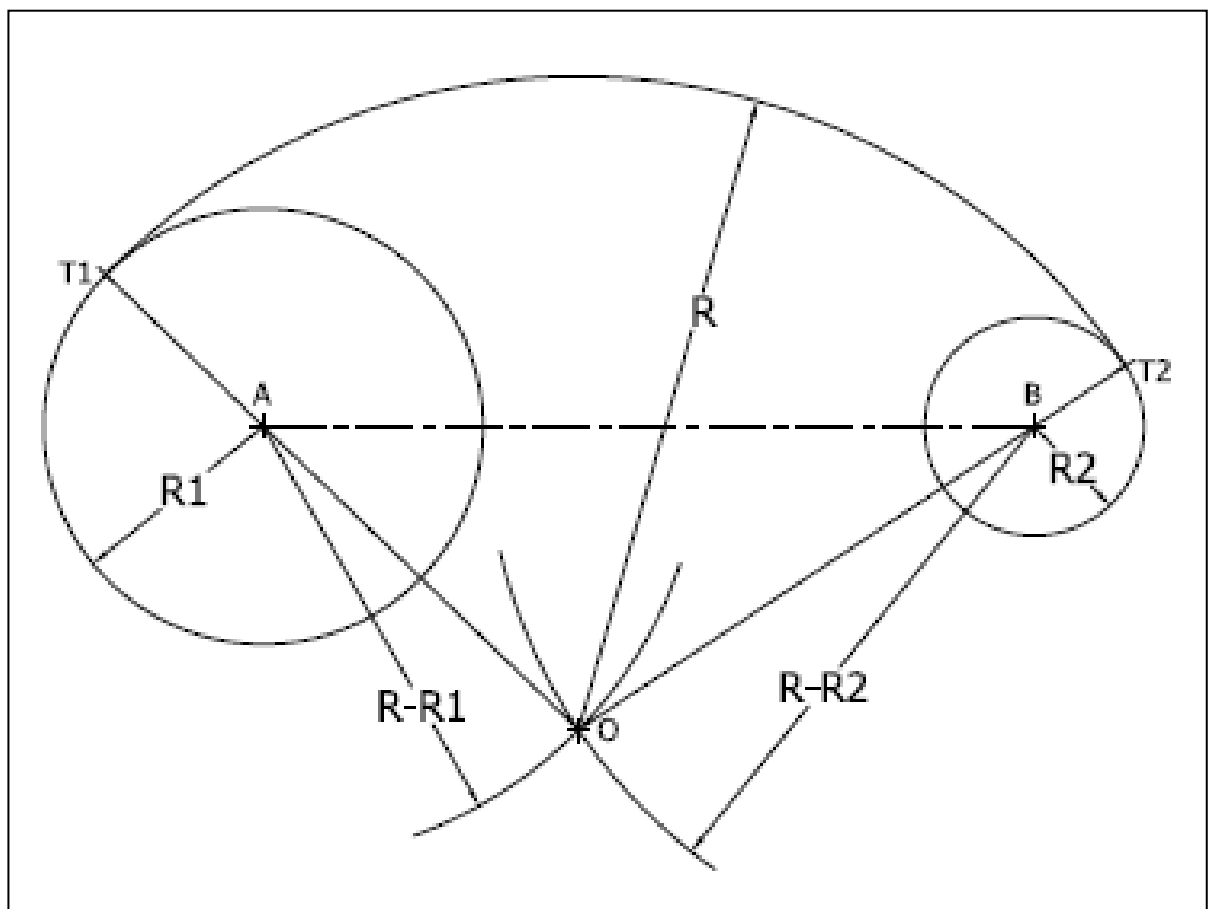


Fig. 25

## 12 To draw a transverse fillet arc tangential to two circles

- a- Let  $R_1$  and  $R_2$  be the radii of the given circles and  $R$  be the radius of the required circle, see Fig. 26.
- b- With center A and radius  $R-R_1$ , draw an arc.
- c- With center B and radius  $R+R_2$ , draw an arc to intersect the previous arc at O.
- d- Join O to A to intersect the given circle at the tangent point T1.
- d- Join O to B to intersect the other given circle at the tangent point T2.
- e- With  $R$  as radius and O as center draw the required fillet between T1 and T2.

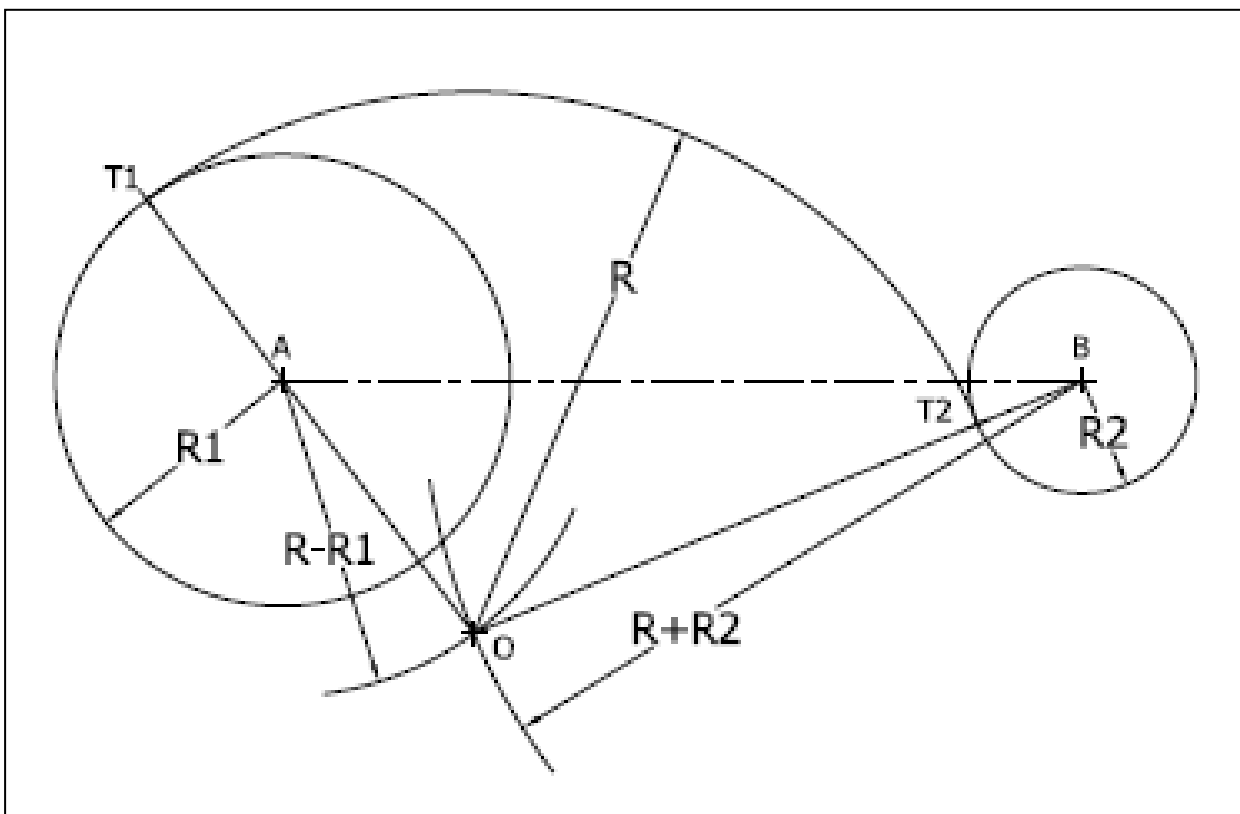


Fig. 26

### 13 To draw an arc tangential to a line and passing through a given point

- a- Let L1 be the given line and Let A be the center of the given circle of radius R1 and P be the given point, see Fig. 27.
- b- With center P and radius R, draw an arc .
- c- On the side of the required fillet center, draw a construction line L2 parallel to the given line L1 and distance R from it to intersect the construction arc at O.
- d- draw line OT1 perpendicular to the given line L1 to get the tangent point T1.
- e- With R as radius and O as center draw the required arc between T1 and P.

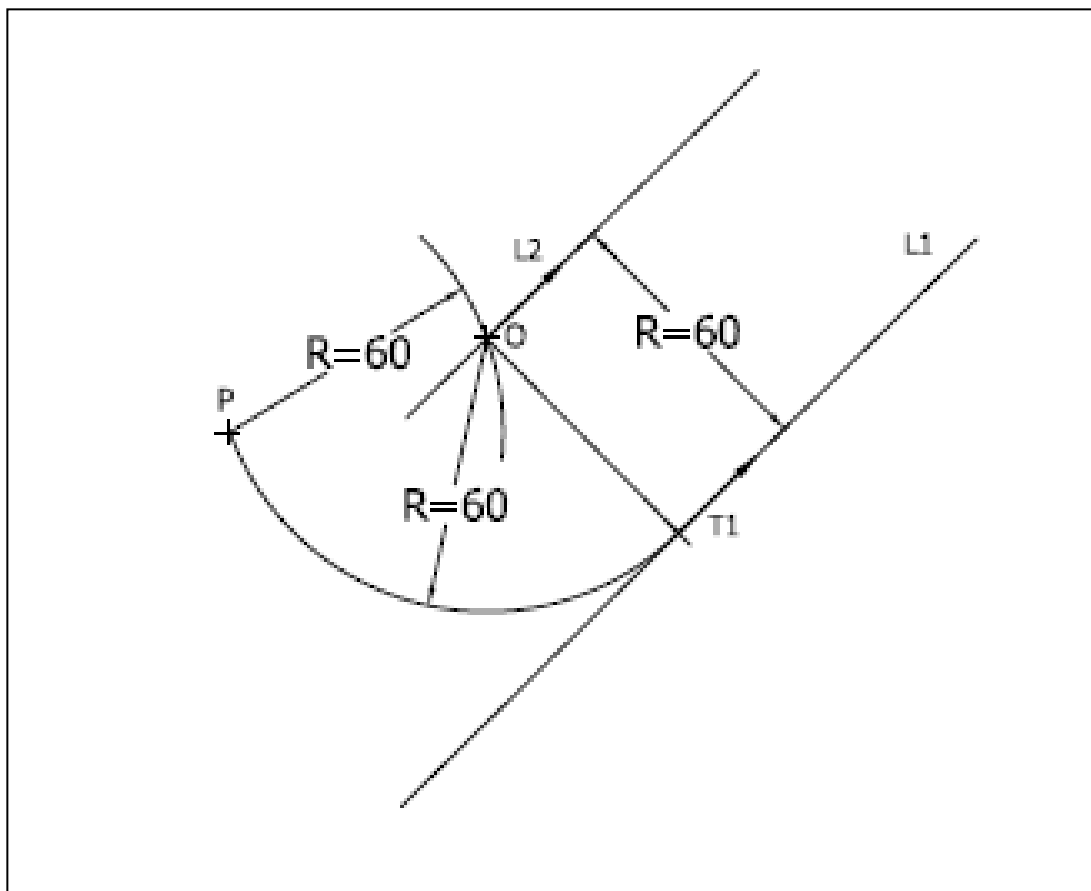


Fig.27



## 14 To draw an arc tangential to a circle and passing through a given point

- a- Let A be the center of the given circle of radius  $R_1$  and P be the given point. Let R be the radius of required arc, see Fig. 28.
- b- With center A and radius  $R+R_1$ , draw an arc.
- c- With center P and radius R, draw an arc to intersect the previous arc at O.
- d- Join O to A to intersect the given circle at the tangent point T1.
- d- With R as radius and O as center draw the required arc between T1 and P.

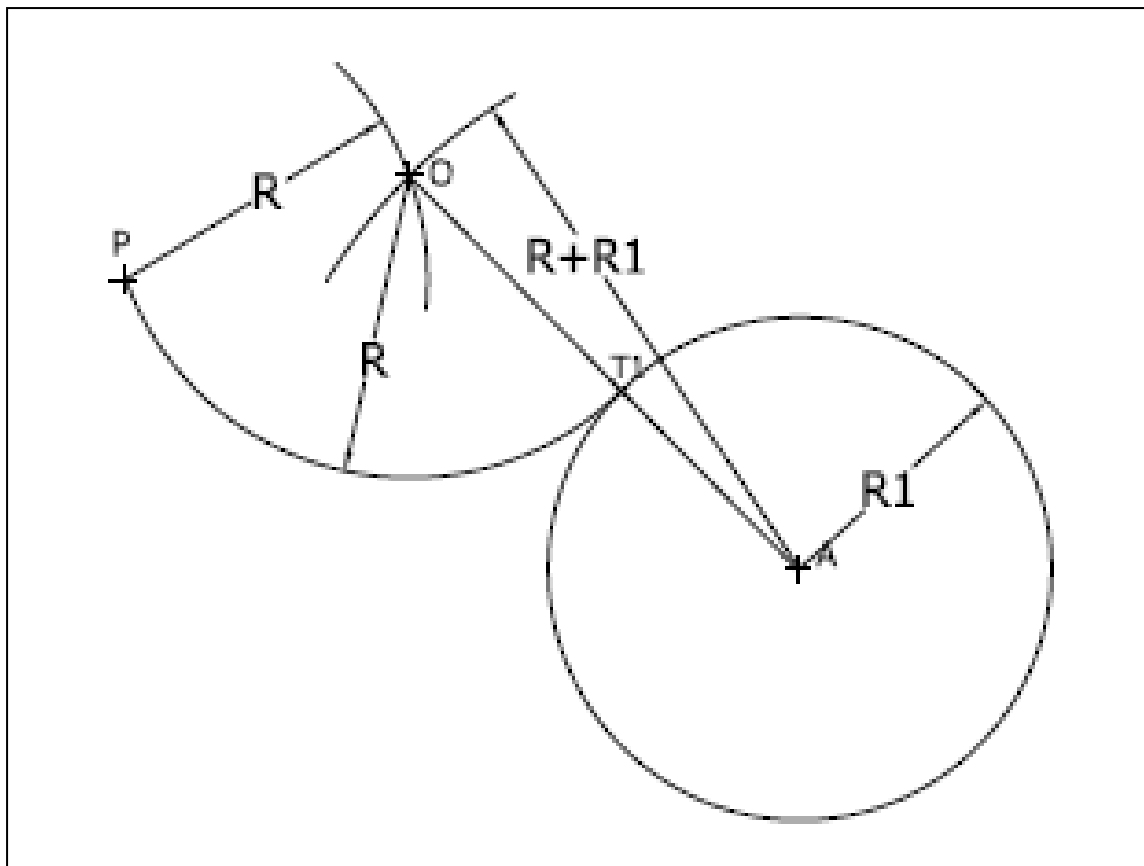


Fig.28

## 15 Reverse Curve

The Reverse curve consists of two circles tangent each other and the centers of which are in opposite directions. The tangent point is called a reverse point. There are two cases of reverse curve. In the first case, the reverse curve tangents to two parallel lines. While in the second case, it tangents to three non parallel lines.

### Case 1: Reverse curve tangent to two parallel lines:

The given is two parallel lines,  $L_1$  and  $L_2$ , tangent to the required reverse curve through the given points A and B. The reverse point, R, is shown in Fig. 29.

This case of reversed curve has the following properties:

- The tangent line at A is parallel to the tangent line at B
- The three points  $O_1$ , R and  $O_2$  are collinear.
- The three points A, R and B are collinear
- $O_1 A$  is perpendicular to the tangent line  $L_1$  at A
- $O_2 B$  is perpendicular to the tangent line  $L_2$  at B
- The common tangent "C R D" at R is perpendicular to the line connecting  $O_1 O_2$
- The length C A is equal to the length C R
- The length D R is equal to D B
- The line C  $O_1$  passes through the center  $O_1$
- The line D  $O_2$  passes through the center  $O_2$
- If the reverse point, R, is not given, you have to know one radius either  $R_1$  or  $R_2$  to get the reverse point R.

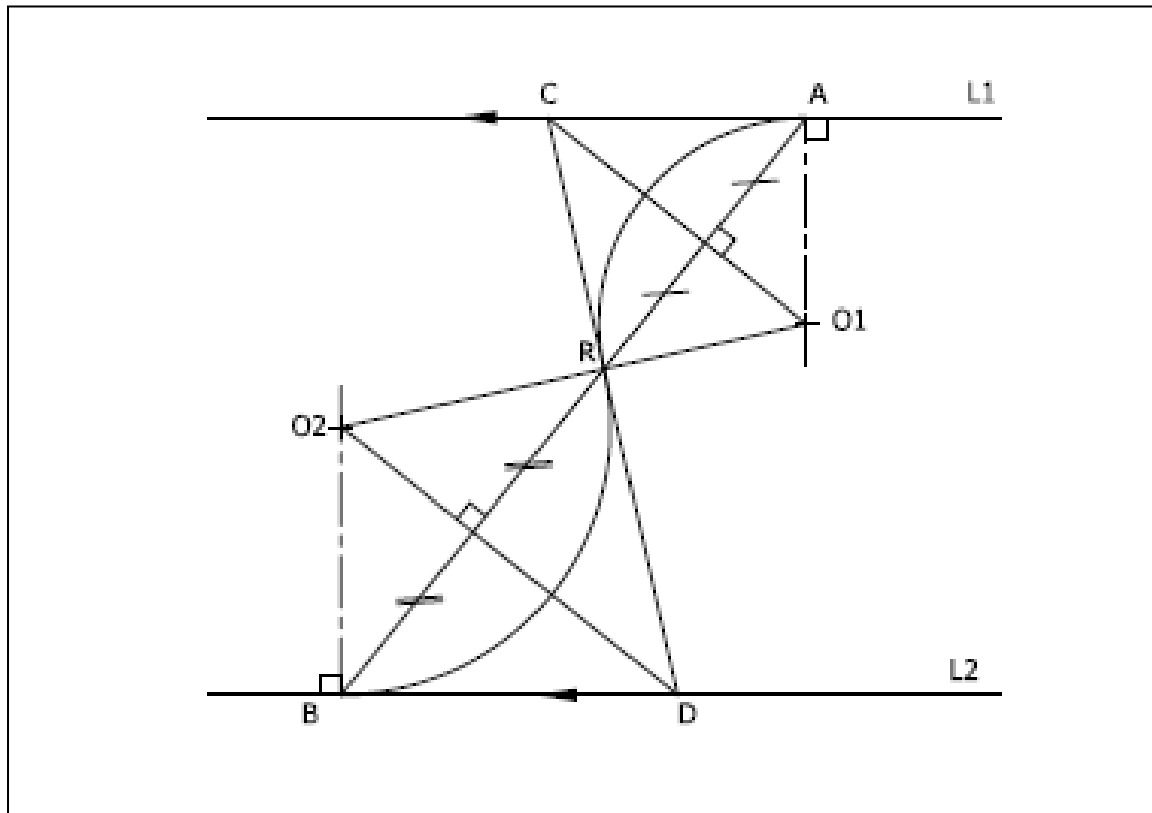


Fig. 29

Solved Example 1

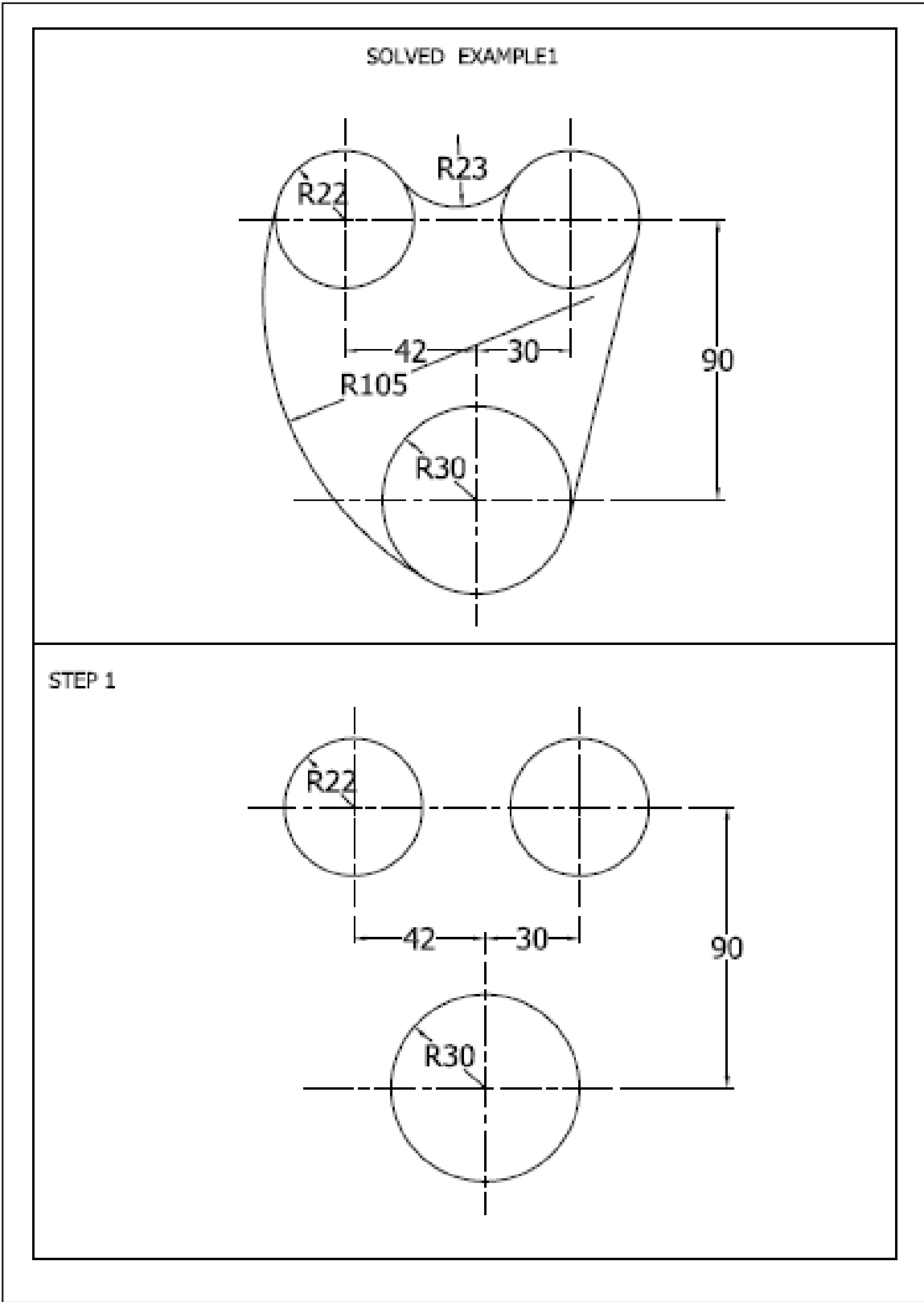
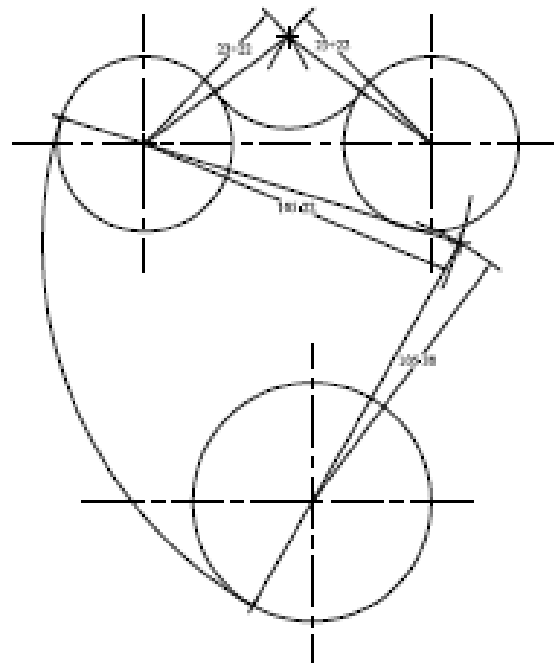


Fig. 30

STEP 2



STEP 3

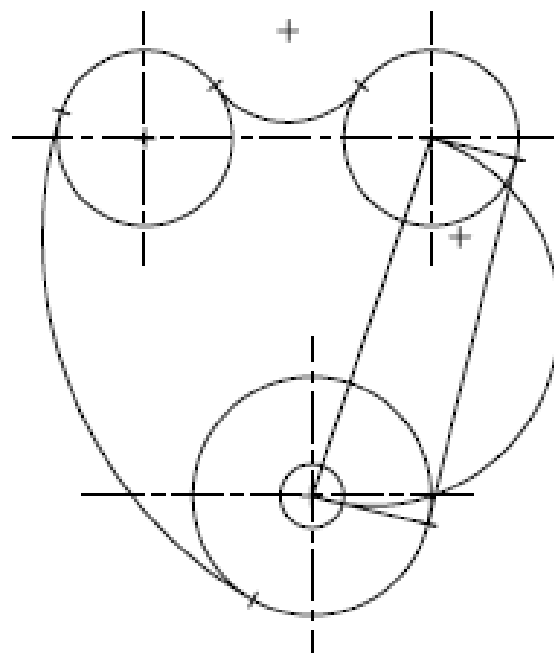


Fig. 31

Solved Example 2

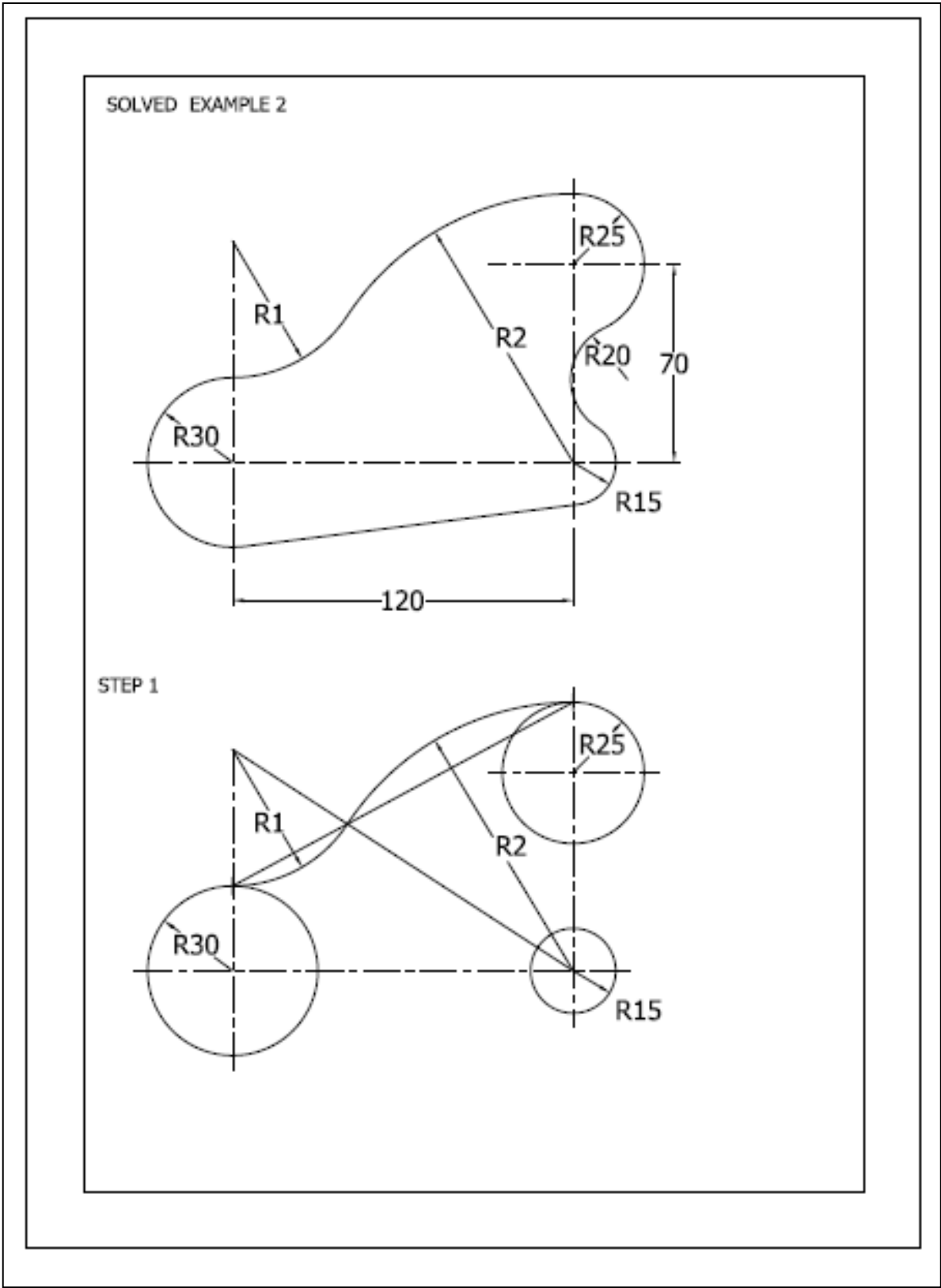
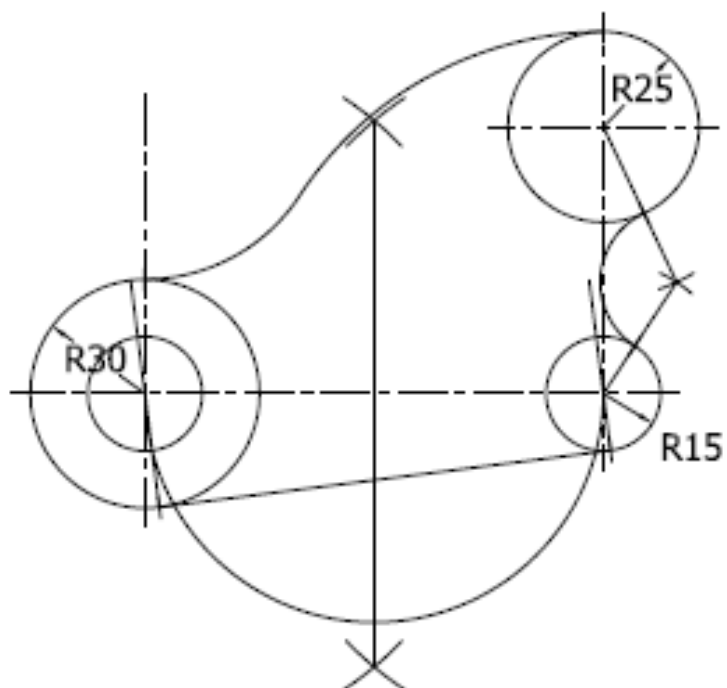


Fig. 32

STEP 2



STEP 3

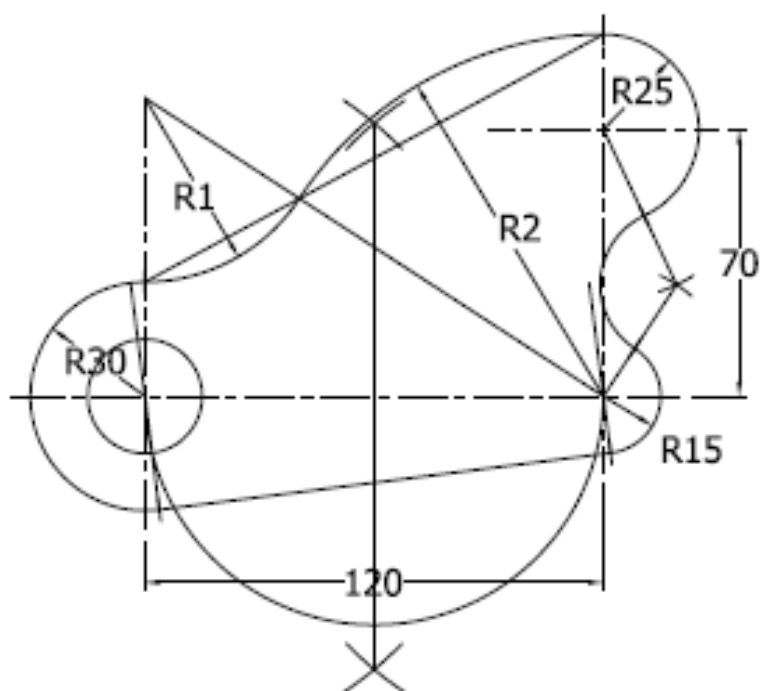


Fig. 33

SOLVED EXAMPLE 3

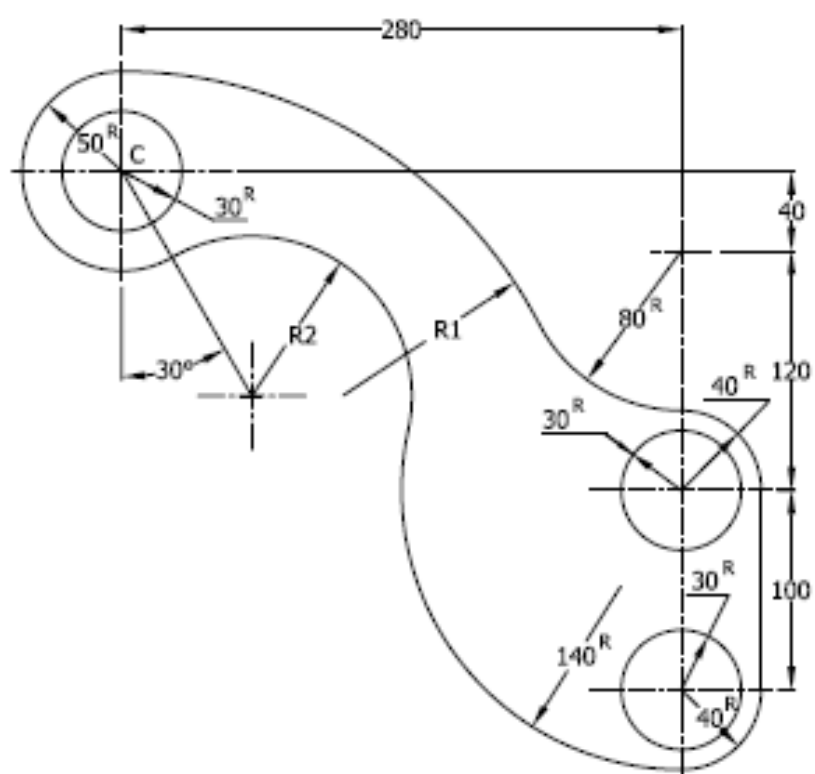


Fig. 34



STEP 1

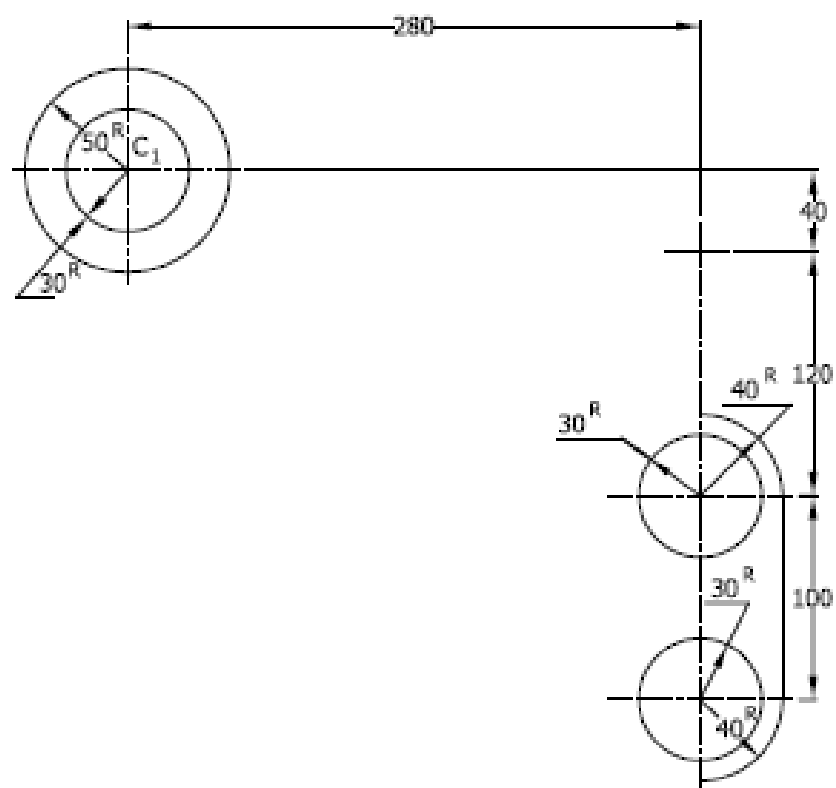


Fig. 35

STEP 2

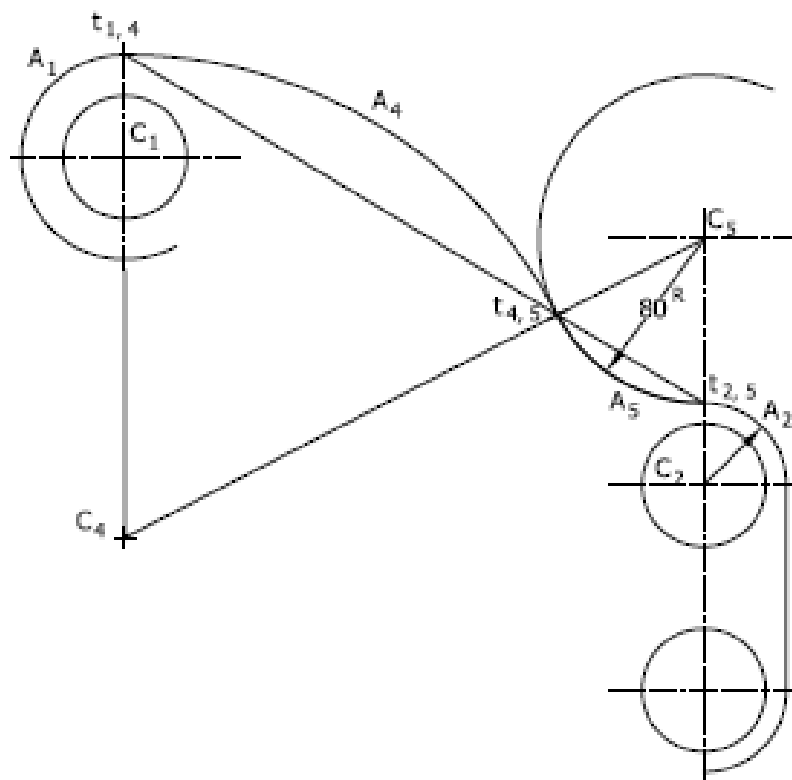


Fig. 36

STEP 3

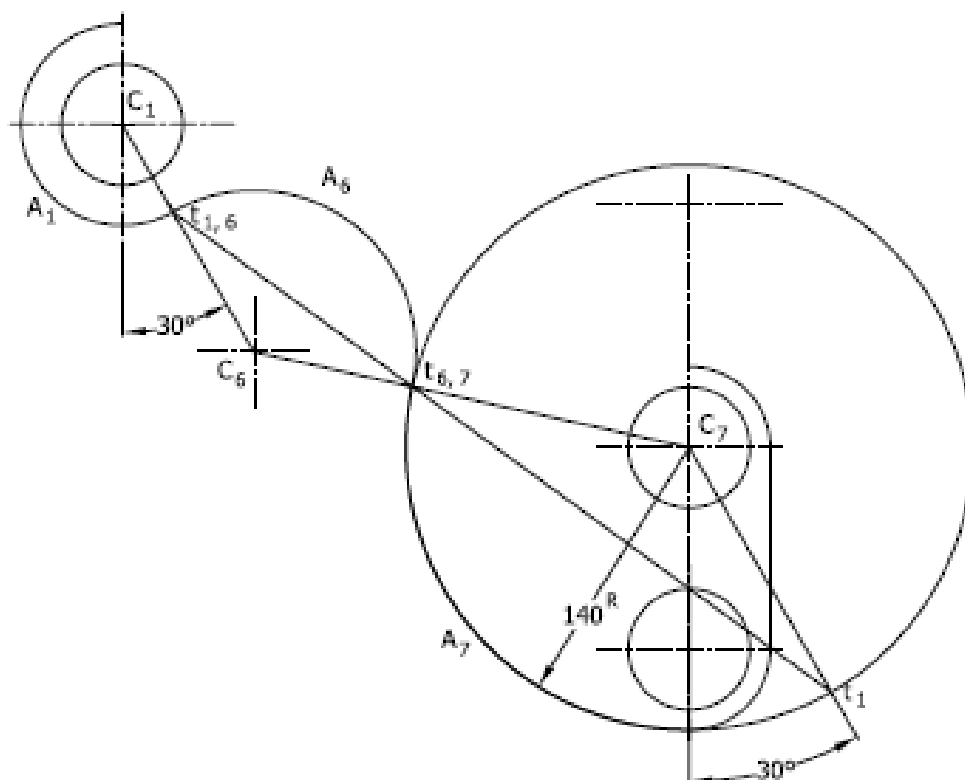


Fig. 37



Assignment 1

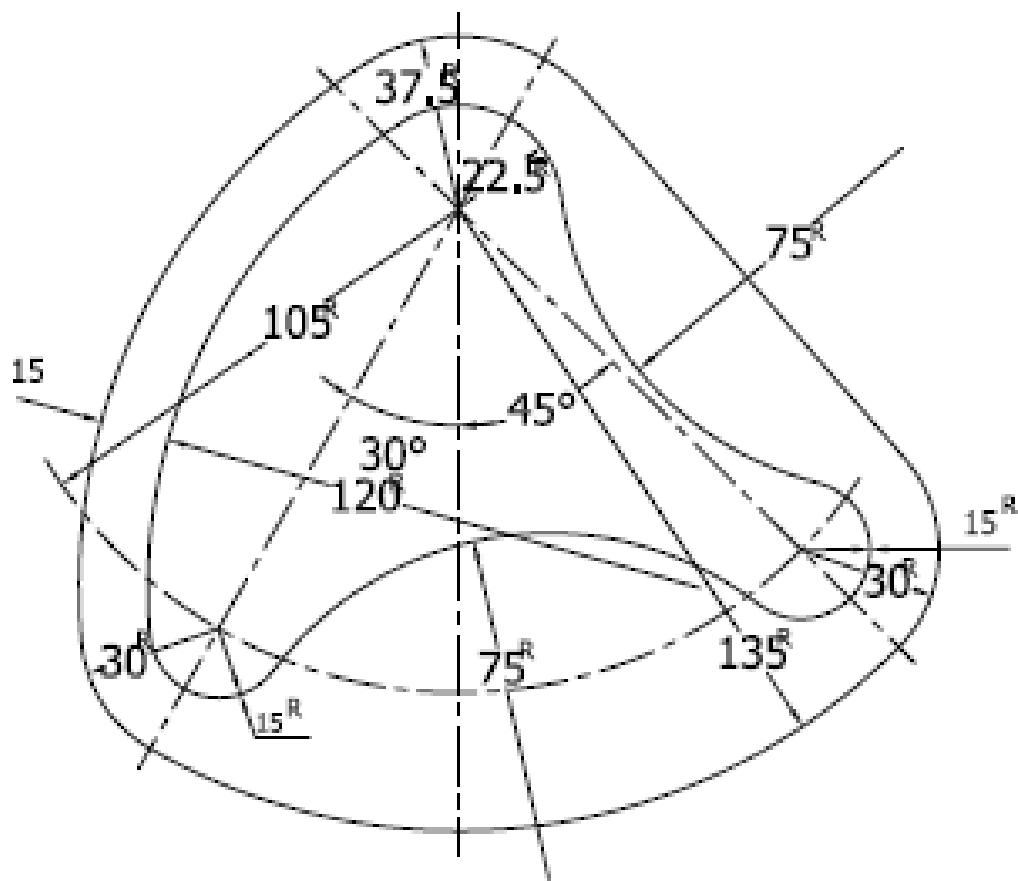


Fig. 39

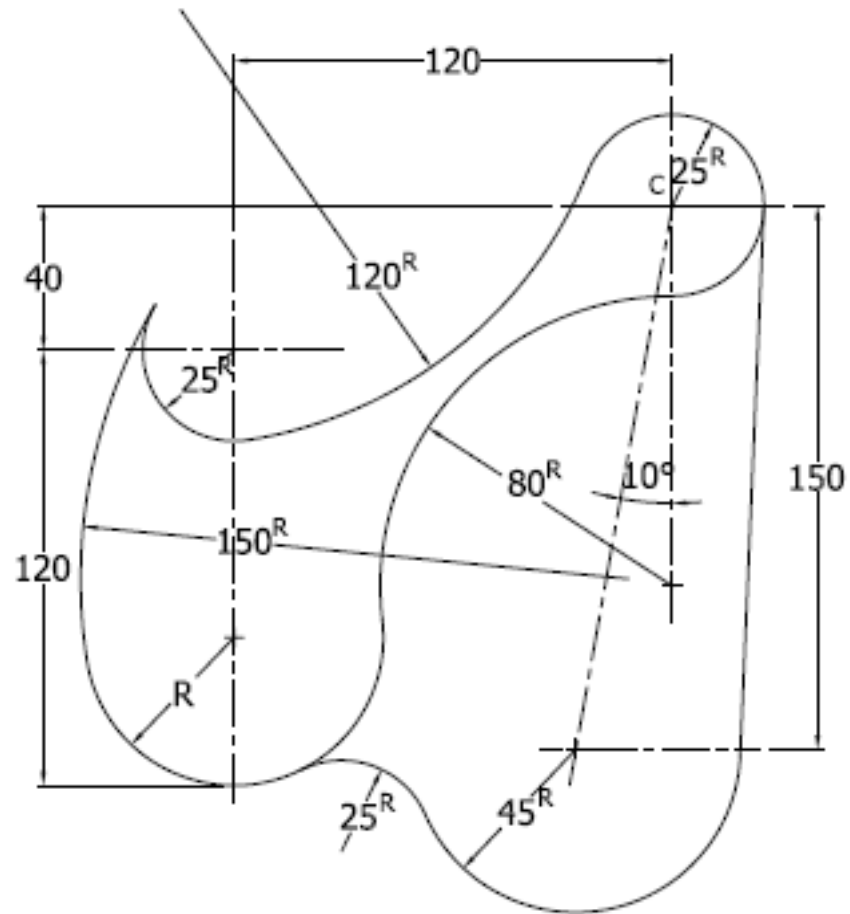


Fig. 40

# CHAPTER 3

## **Geometric and Special Curves**

### **Conic Sections:**

The plane section of right cone has many shapes according to its angle of inclination with the axis of the cone, see Fig. 41. When the cutting plane is perpendicular to the axis of cone, the shape of conic section is a circle. If the angle of cutting plane with the axis of cone is greater than that between the generatrix and the axis, the shape of conic section will be ellipse. But it will be Hyperbola if the angle of cutting plane to the axis is smaller than that of generatrix. The shape of conic section will be Parabola if the angle of cutting is equal to that of generatrix.

Fig. 41

## **1. Ellipse**

Ellipse is defined by the length of its major axis AB and minor axis CD, as shown in Fig. 33. These two axes may be either perpendicular to each other or not. Here, we will explain some methods used to draw the ellipse which its axes are perpendicular to each other. These methods lead to the construction of true ellipse or expressing the ellipse by an approximate curve consists of four circular arcs.

### **1.1 True ellipse**

As mentioned above, both major axis AB and minor axis CD will be given. One of the true methods is called "two concentric circles method".

To draw a true ellipse using this method, do the following steps:

- a- Draw two concentric circles equal in diameter to the major axis AB and the minor axis CD of the required ellipse, see Fig. 42.
- b- Divide the circles into a number of equal parts with radial lines crossing the inner and outer circles.
- c- Where the radial lines cut the inner and outer circles, draw horizontal and vertical lines respectively. The points of intersection C, 1, 2, 3 and B are points on the ellipse.
- d- Draw a uniform bold curve through the intersection points to form the required ellipse.



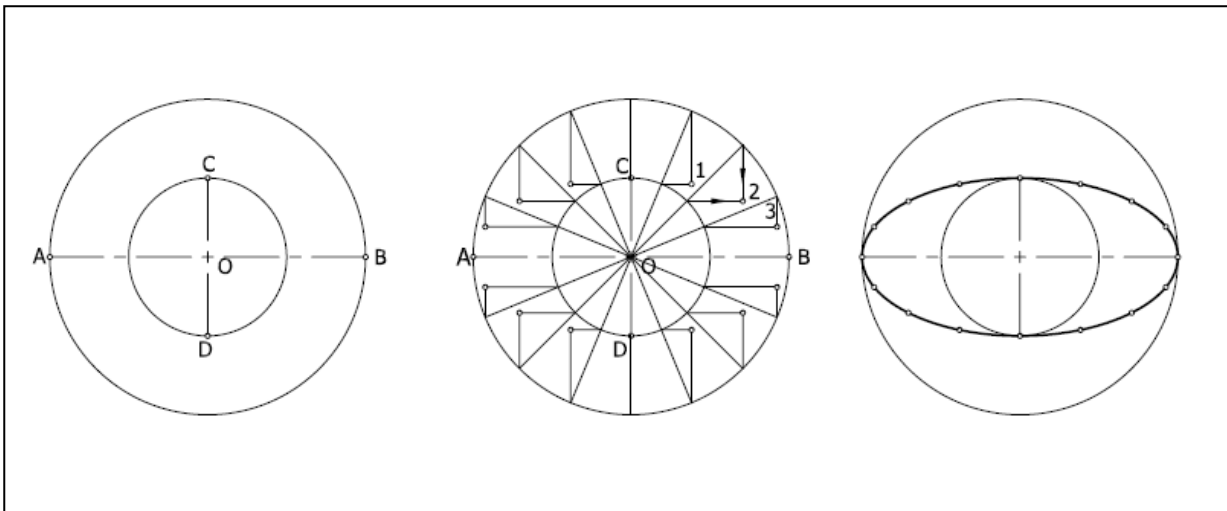


Fig. 42

## 1.2 Approximate ellipse

To draw an approximate ellipse using four centers method

- a- Let  $L_1$  be the semi-major axis  $AB$  and  $L_2$  the semi-minor axis  $CD$  of the required ellipse as shown in Fig. 43.
- b- Join  $CB$  and mark point  $E$  at distance  $L_1 - L_2$  from point  $C$ .
- c- Bisect  $EB$  at  $F$ . From  $F$  construct a perpendicular to  $EB$  to intersect the major axis at  $C_1$  and the minor axis at  $C_2$ . Using symmetry, transfer  $C_1$  to  $C_3$  and  $C_2$  to  $C_4$ .
- d- With centers at  $C_1$  and  $C_3$ , draw tangential arcs of radius  $R_1$ .
- e- With centers at  $C_2$  and  $C_4$ , draw tangential arcs of radius  $R_2$ .

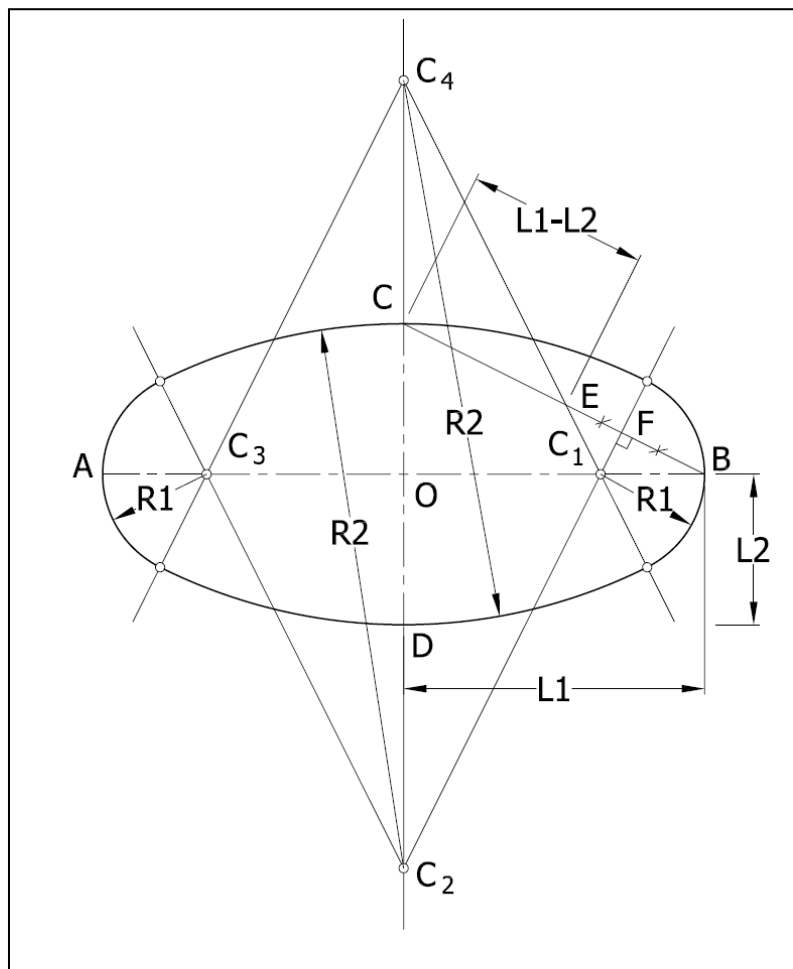


Fig. 43

## 2. Parabola

Parabola is geometrically defined by its width and depth (or span and rise), as shown in Fig. 44. To draw the parabola, do the following the steps:

- a- Divide DB into any number of equal parts (e.g., 8 parts). Also divide BF into the same number of equal parts. Starting from point D, number the divisions toward Point B. Starting from point F, number the points toward point B.
- b- Through the points of DB, draw straight rays parallel to DC. Also from C, draw straight rays to the points of FB.
- c- The rays of the same numbers intersect each other at points belonging to the required parabola.
- d- Use the symmetry to determine the other points of the left half of the parabola.

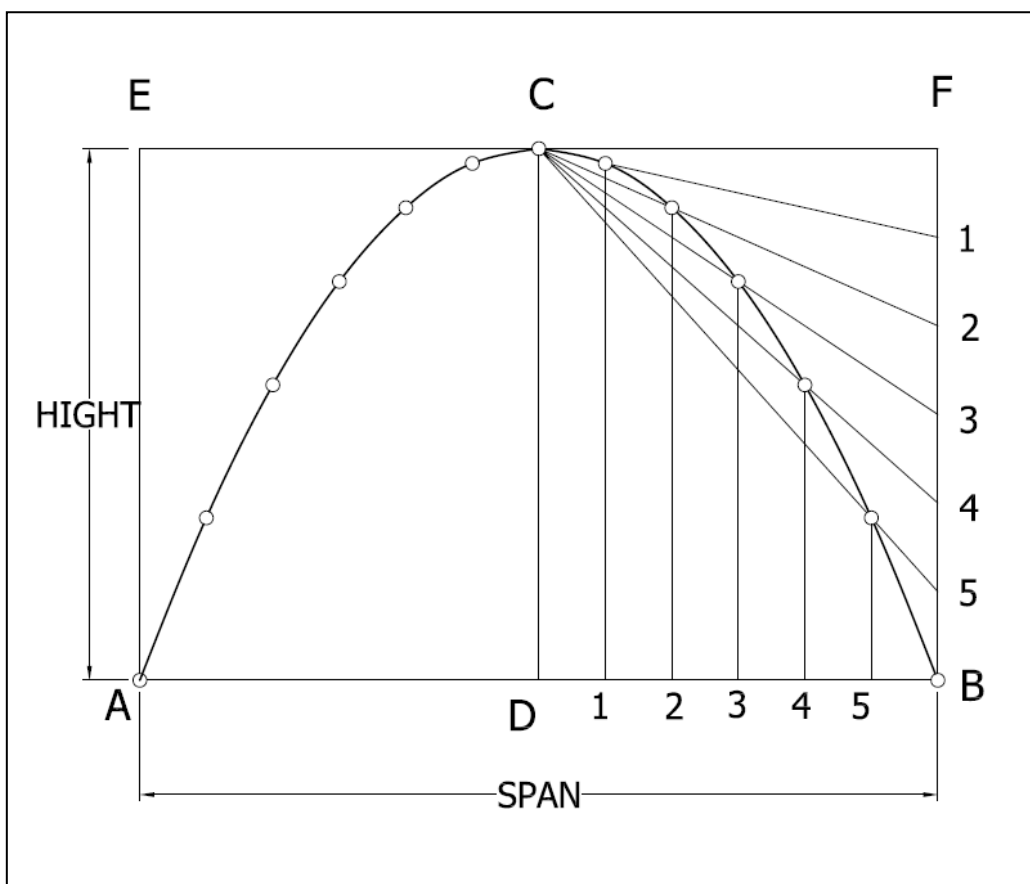


Fig. 44

### 3. Hyperbola

Hyperbola is specified geometrically, by two foci  $F_1$  and  $F_2$  and its transverse axis  $AB$ .  $A$  and  $B$  are the vertices of the hyperbola. To draw the hyperbola, do the following steps.

- a- Determine the mid point  $O$  of  $AB$  and draw perpendicular to  $AB$ .
- b- With  $O$  as center and radius equal to  $OF_1$ , draw an auxiliary circle, as shown in Fig. 45.
- c- From  $A$  and  $B$  draw perpendicular lines to  $AB$  intersecting the previous circle at  $K_1$  and  $K_2$ , respectively.
- d- Join  $OK_1$  and  $OK_2$  to find the asymptotes of the hyperbola.
- e- To obtain any point such as,  $P_1$ , on the hyperbola, draw a circle with center  $F_2$  and arbitrary radius  $R_1$  and another circle with center  $F_1$  and radius equal to  $(R_1 + AB)$ . The intersection point of these two circles is  $P_1$ .
- f- Repeating the last step with changing the value of arbitrary radius  $R_1$ , one can obtained more points on the required hyperbola.

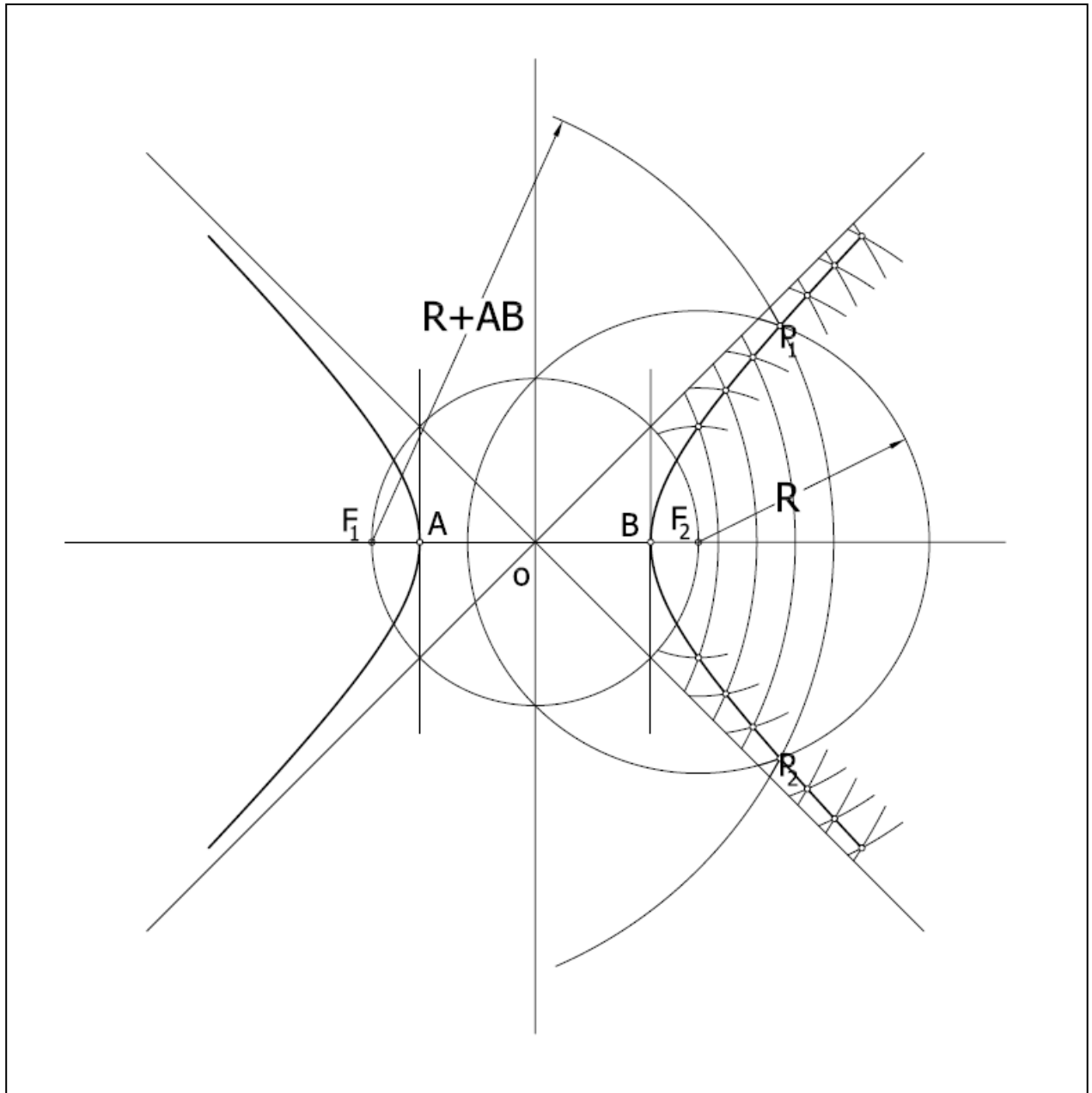


Fig. 45

## 4. Helix

Helix is a space curve drawn by a point moving in helical motion about an axis  $v$ . The distance between this point and the axis is called the radius of helix. Helical motion is the resultant motion of point moves with two velocities. The first is circular and the other is axial. The axial distance which needs one complete circulation is called the pitch  $P$  of helix. The helix can be drawn by dividing the circle and the pitch  $P$  of helix. The helix can be drawn by dividing the circle and the pitch into the same number of points as shown in Fig. 46.

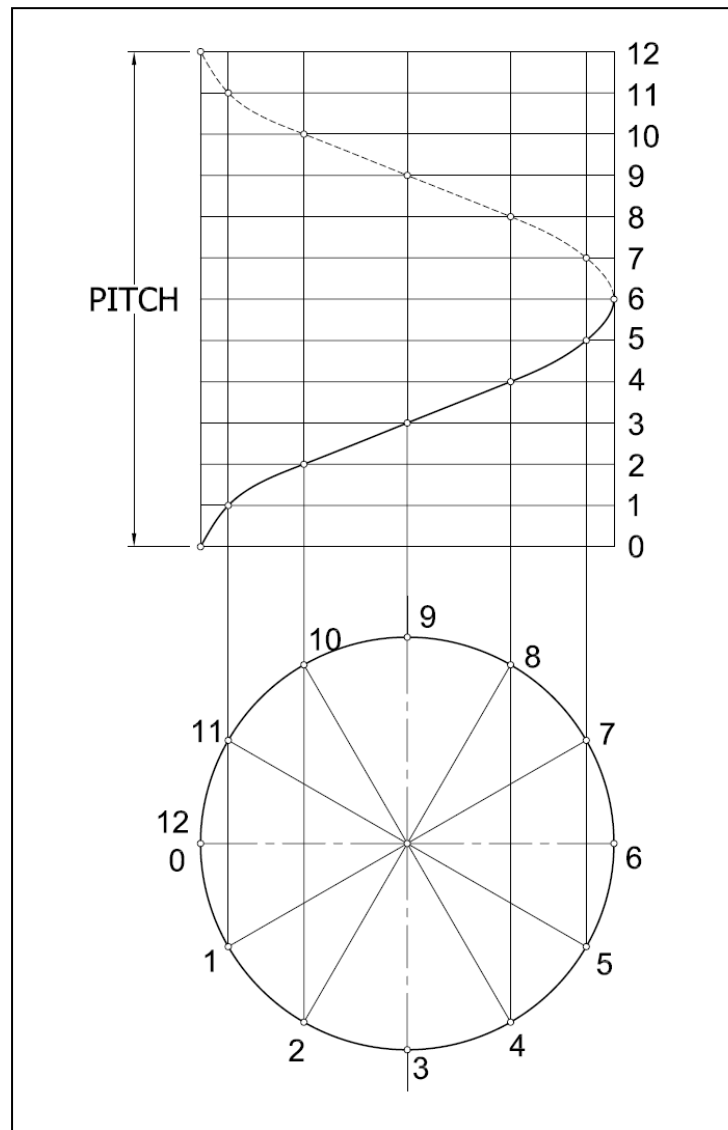


Fig. 46

# CHAPTER 4

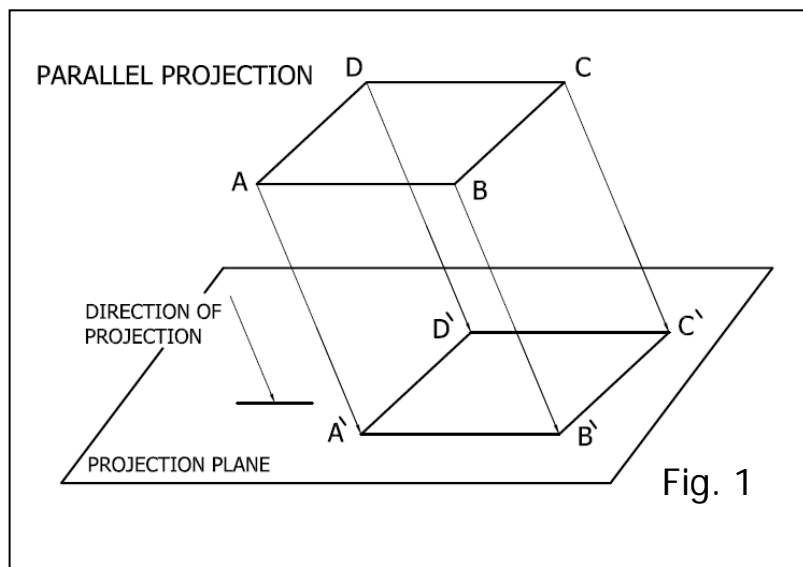
## Theory of Projection

### 1. Introduction

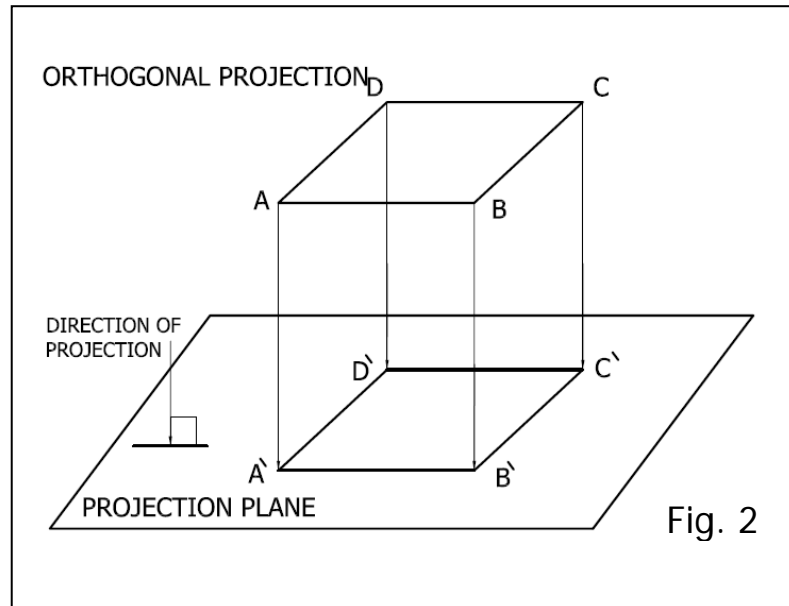
There are many types of projections depending on what is the direction of projection. Direction of projection is the direction at which the rays project the points of an object on the plane of projection, as shown in Figures 1 and 2.

### 2. Conception of Projection

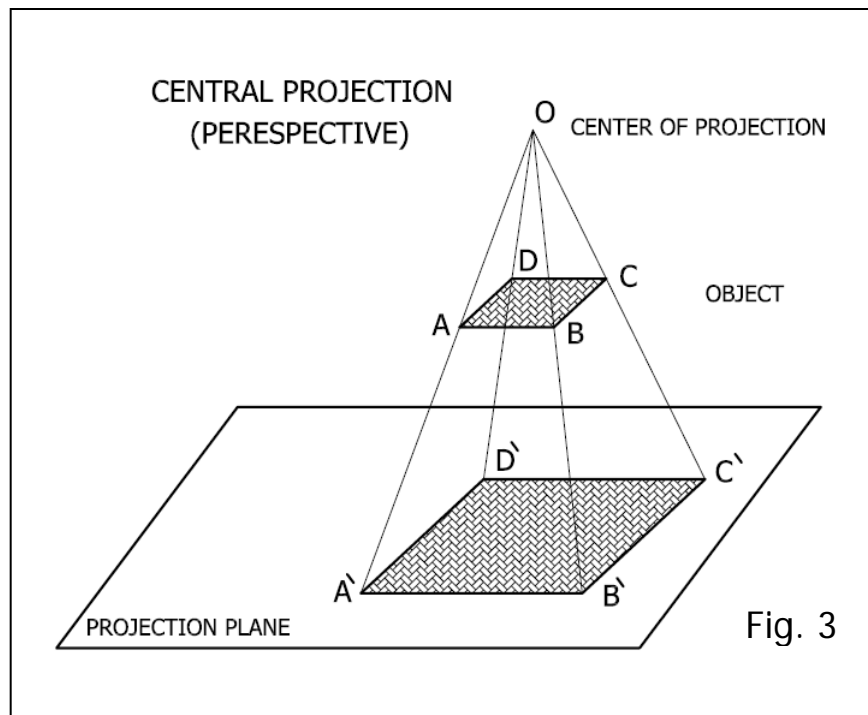
In order to project an object such as rectangle ABCD on a plane  $\pi$  in the direction  $d$ , we draw imaginary projectors (rays) parallel to  $d$  and passing through A, B, C and D and extend them to intersect the projection plane  $\pi$  at  $A'$   $B'$   $C'$   $D'$  as shown in Fig. 1. the rectangle  $A' B' C' D'$  is called the projection of ABCD on the projection plane through the direction of projection  $d$ .



Since all projectors (rays) are parallel to the direction of projection, this type of projection is called parallel projection. A particular case called orthographic projection is taken place when the rays are perpendicular to the projection plane  $\pi$ , see Fig. 2.



The other common type of projection is call central projection, see Fig. 3.





## **2.1 Orthographic Projection**

Orthographic projection is a method of representation for an object by means of parallel projectors perpendicular to the plane of projection as shown in Fig. 2.

## **2.2 Central Projection (Perspective Projection)**

Figure 3 illustrate the basic theory of central projection. The projectors emanate from points of the object and converge to an observer whose position is called the center of projection  $s$ . So, it is a common projection on which projectors converge to point  $s$ .

## **2.3 Bi-orthographic Projection**

Then, the objectors are generally described in engineering fields by means of projections. For the most time and for the great bulk of projects in the engineering work, the orthographic projection is used. Through the orthographic projection, separate views arrange all details of the represented object.

Orthographic projection is a technique of representation. The complete details of the pictorial objects are generally produced by dragging all points of the object to a three mutual perpendicular reference planes through perpendicular imaginary rays as shown in Fig. 4. These mutual perpendicular reference planes are called planes of projection. Also, three planes of projection are the common reference planes which are consist of the three

# ORTHOGRAPHIC PROJECTION

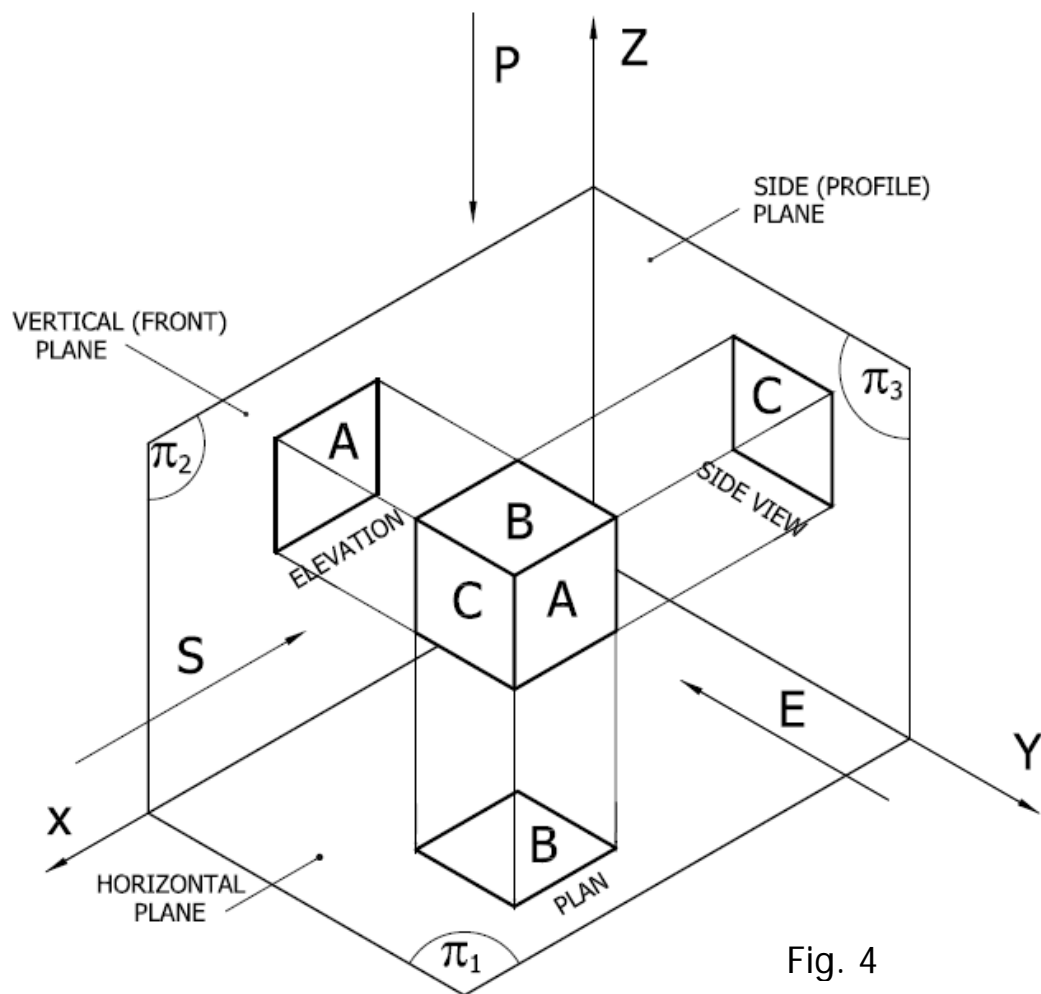


Fig. 4

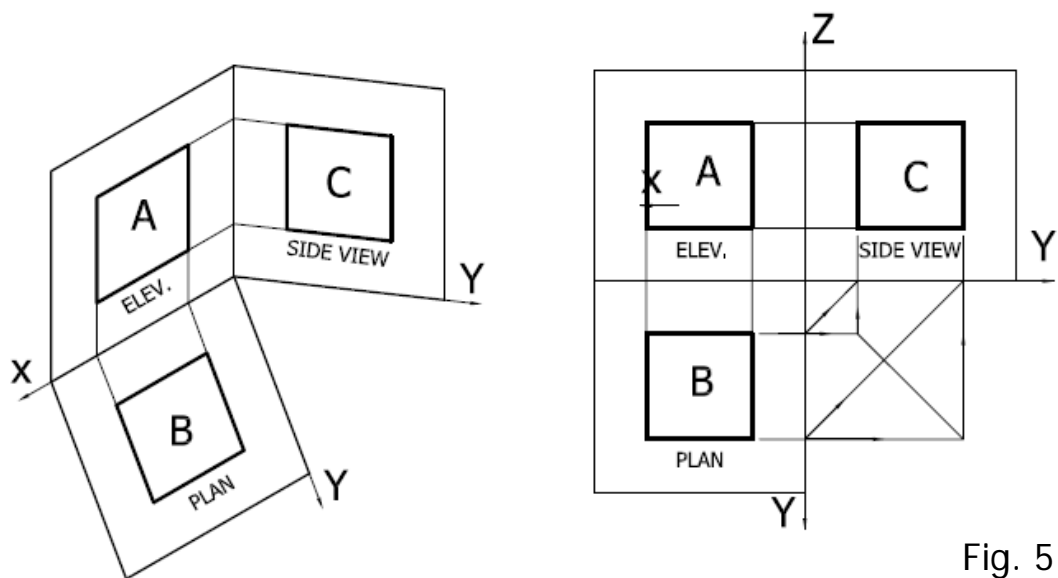


Fig. 5

perpendicular axes  $x$ ,  $y$  and  $z$ . They are: (vertical plane or frontal, horizontal plane and lateral or profile plane).

The frontal plane contains the frontal projection (called Elevation or Front View). The horizontal plane contains the horizontal projection (called PLAN or TOP view) but the profile plane contains the profile projection (called SIDE VIEW).

If the horizontal plane is rotated about the  $x$ -axis and the profile plane is rotated about  $z$ -axis to be coincident with the frontal plane, the three views appear in the same paper of drawing as shown in Fig. 5.

The produced views describe the 3-D object completely. Two views are enough to completely describe all details of the three dimension object.

Because two views are sufficient to represent the 3-D objects, this projection is sometimes called bi-orthographic projection.



### 3. First and Third Angle Projection

The orthographic projection is classified to two types according to the position of the 3-D object with respect to the planes of projection. If the 3-d object is put at the first angle, the produced projection is called first angle projection as shown in Fig. 6.

In this case the three view are arranged in a way that makes the ELEVATION is essential view to connect the other two views where the plan is drawn below it and the side view is drawn at its right side as in Fig. 6.

If the 3-D object is put at the third angle, the produced projection is called third angle projection. In this case the three views are arranged in a way that makes the PLAN is the essential view to connect the other two views where the ELEVATION is drawn above it and the SIDE VIEW is drawn at its right side.

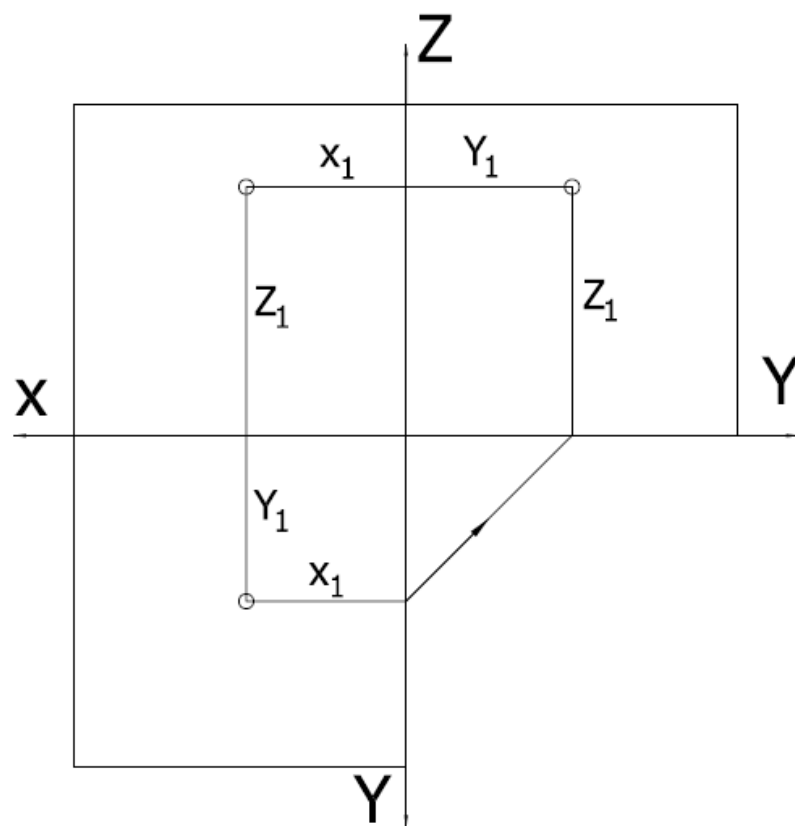
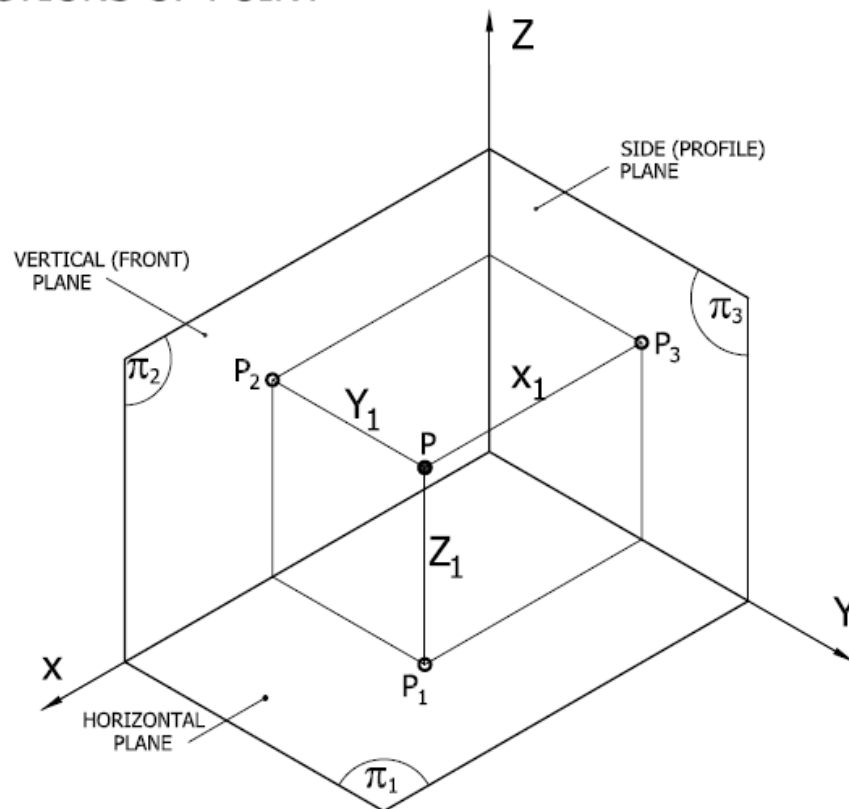


#### **4. Projection of Point, Straight Line and Plane**

The objects are referred to three mutually perpendicular planes. Thus points, lines and planes can be represented by three views connecting each other according to the positions of all given points. To understand the concept of the distribution of coordinates on three views of an object, let us understand it for the projections of point shown in Fig. 7. It is known that the side view can be obtained from the given plan and elevation. The rotation of y-coordinate from the plan to side view is used with a horizontal motion from elevation to obtain side view.

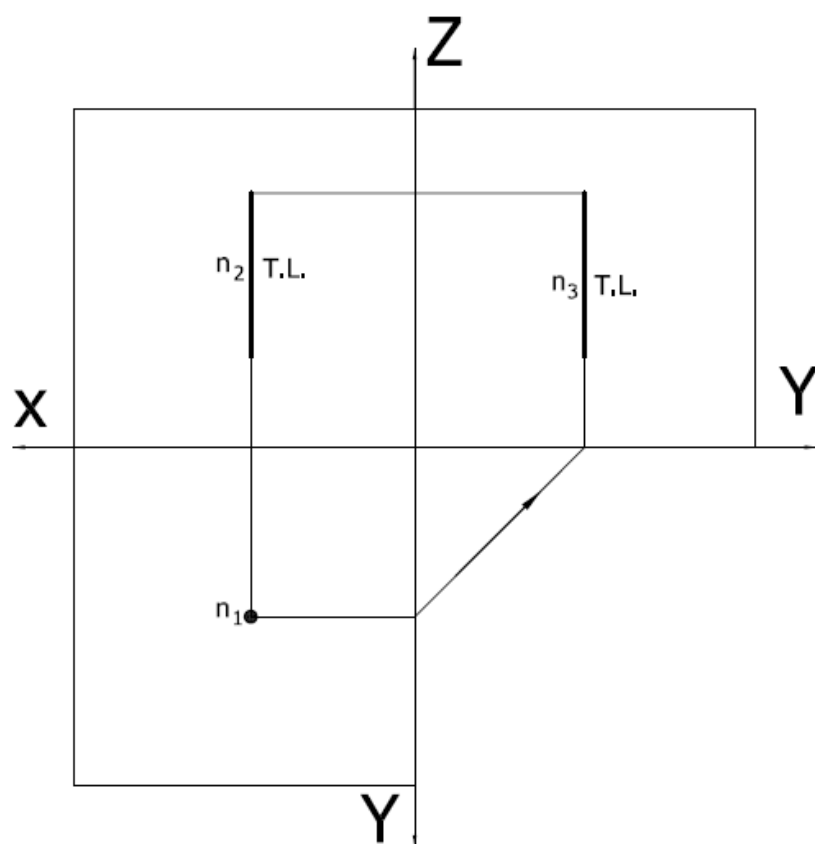
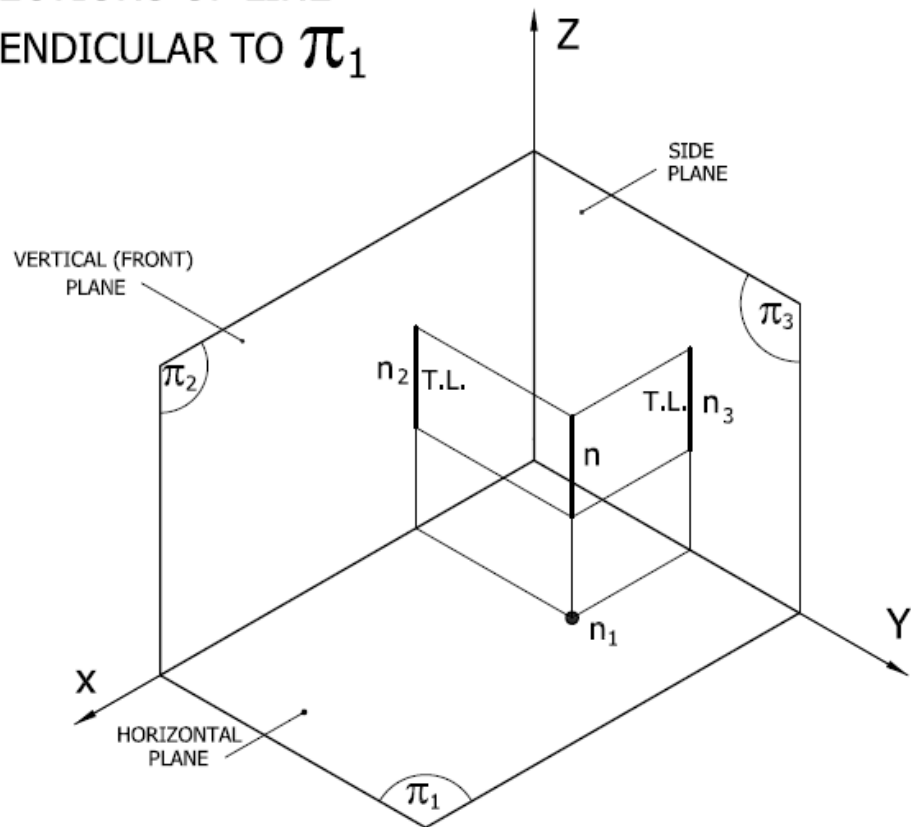
The following figures illustrate the projection of various positions of lines and planes. Each illustrated line is formed by connecting its end points while each plane is formed by connecting its nodal points. It should be noticed that every point is projected as previously shown in Fig. 7.

# PROJECTIONS OF POINT

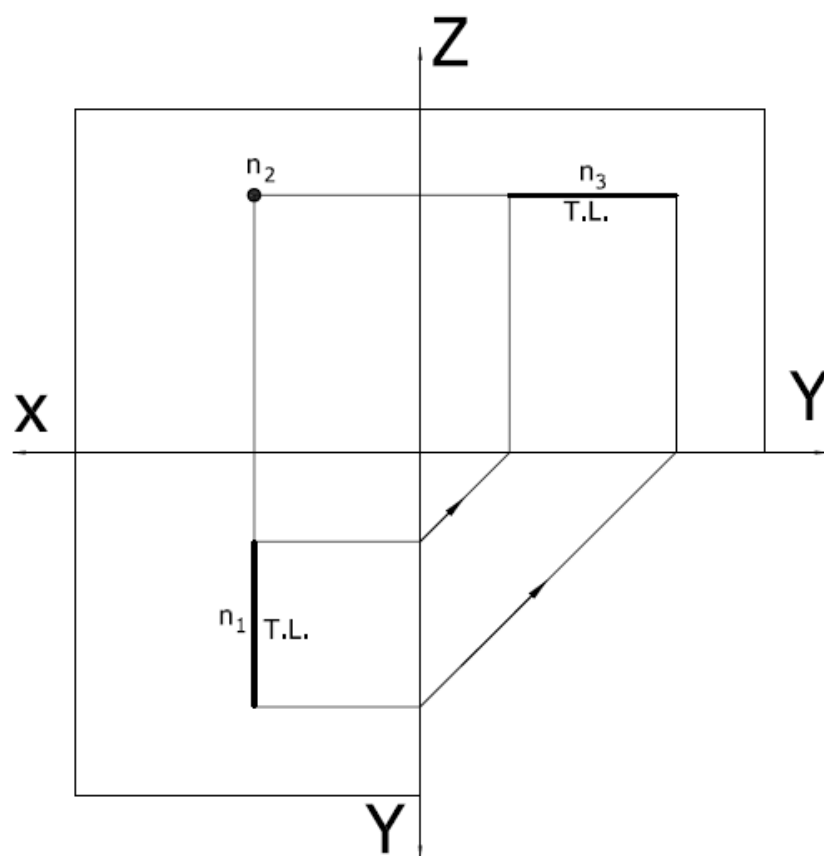
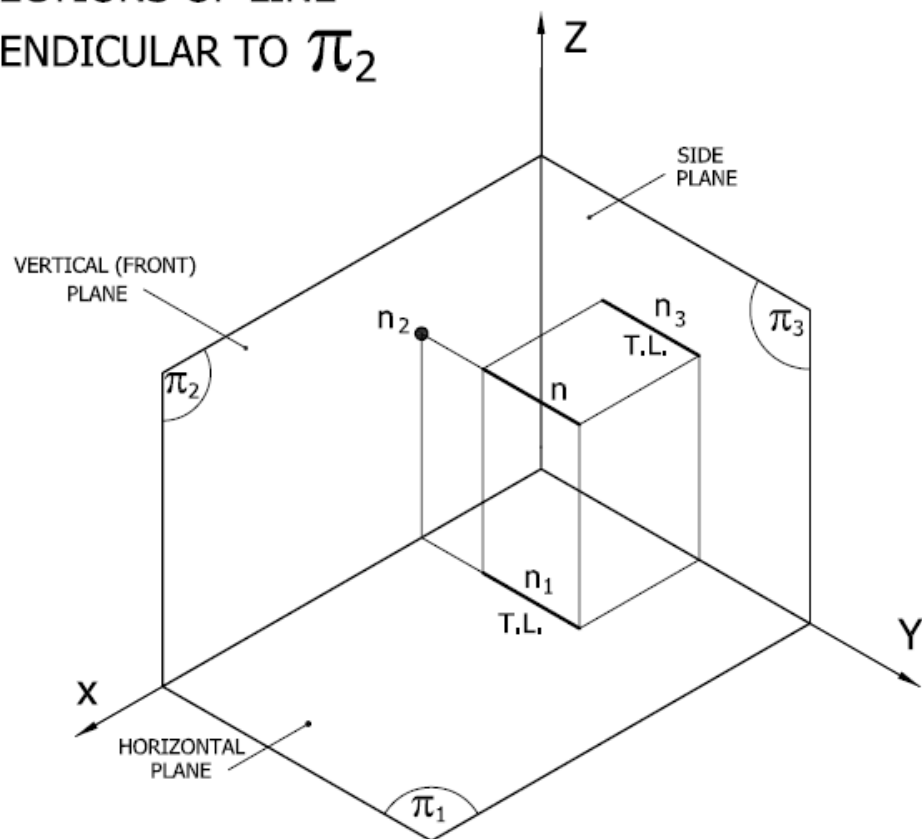




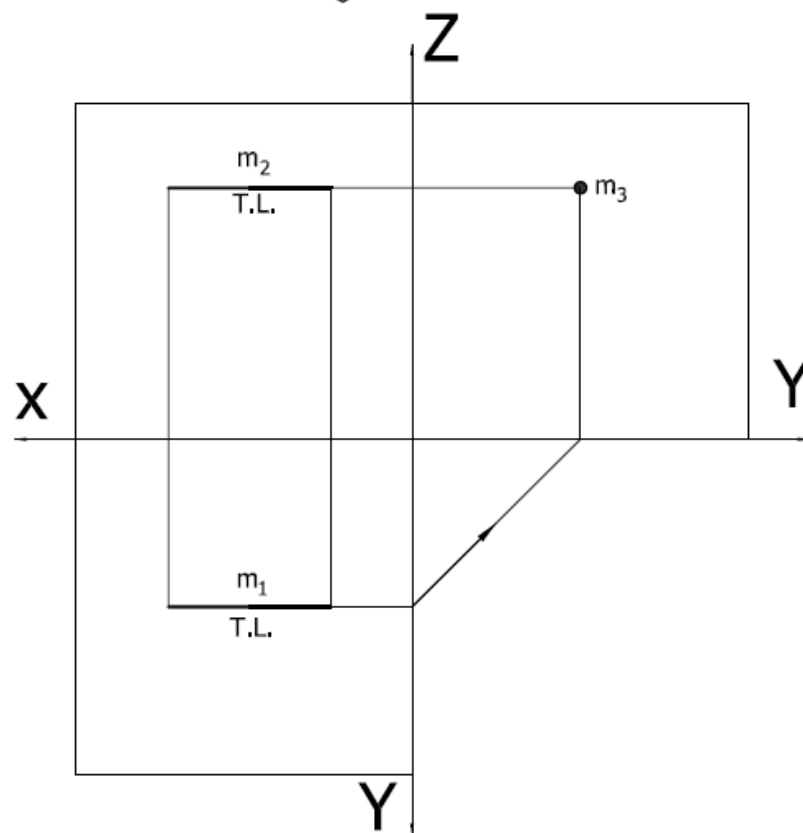
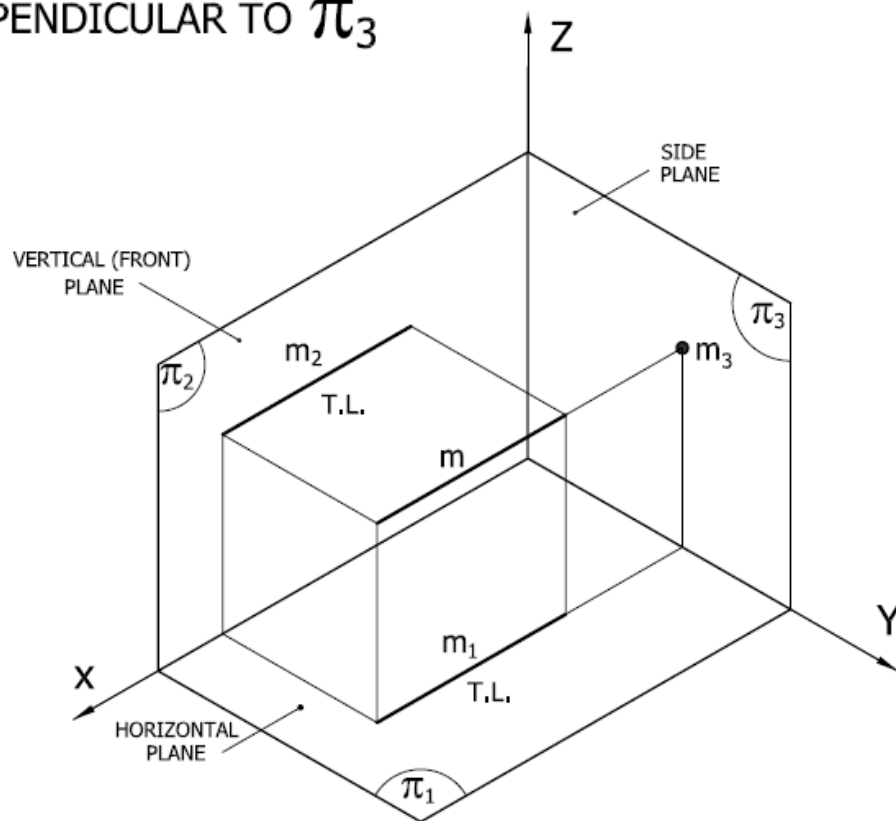
# PROJECTIONS OF LINE PERPENDICULAR TO $\pi_1$



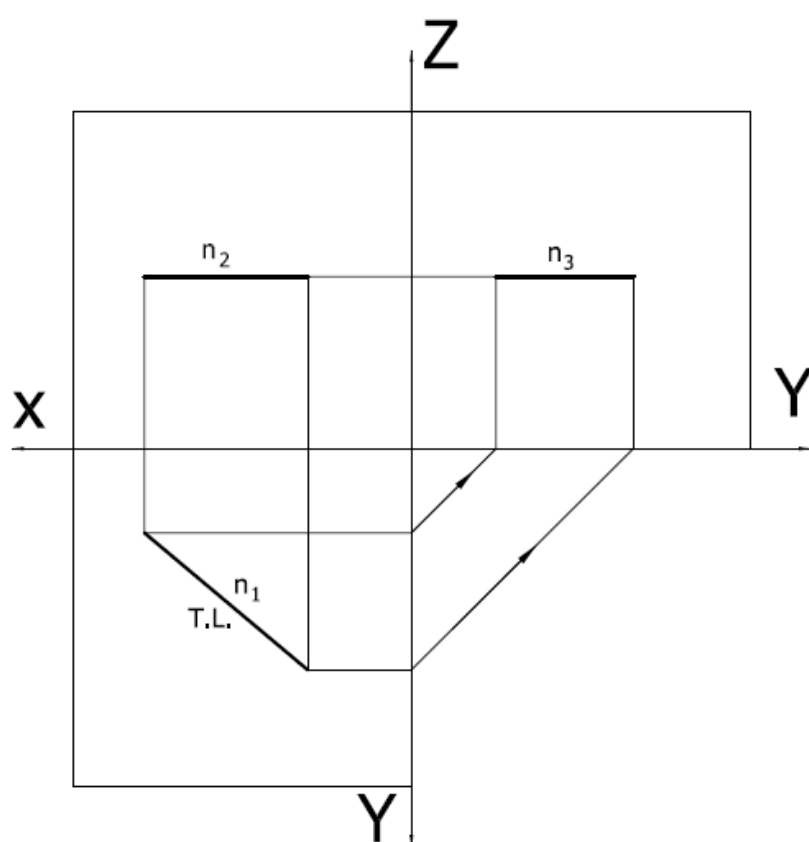
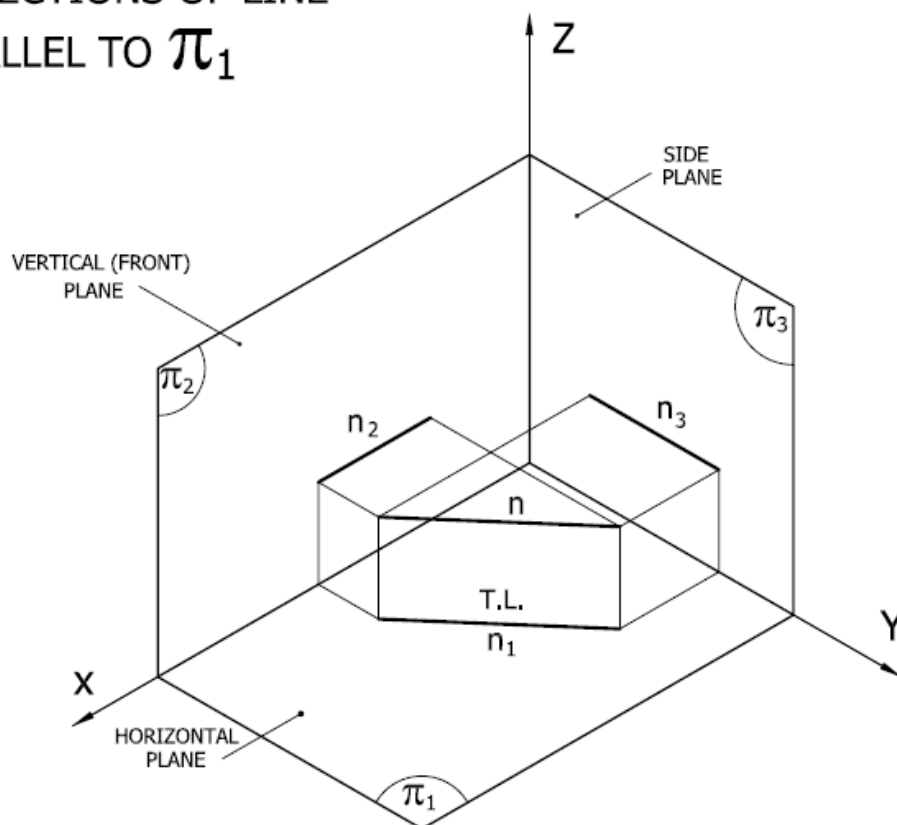
# PROJECTIONS OF LINE PERPENDICULAR TO $\pi_2$



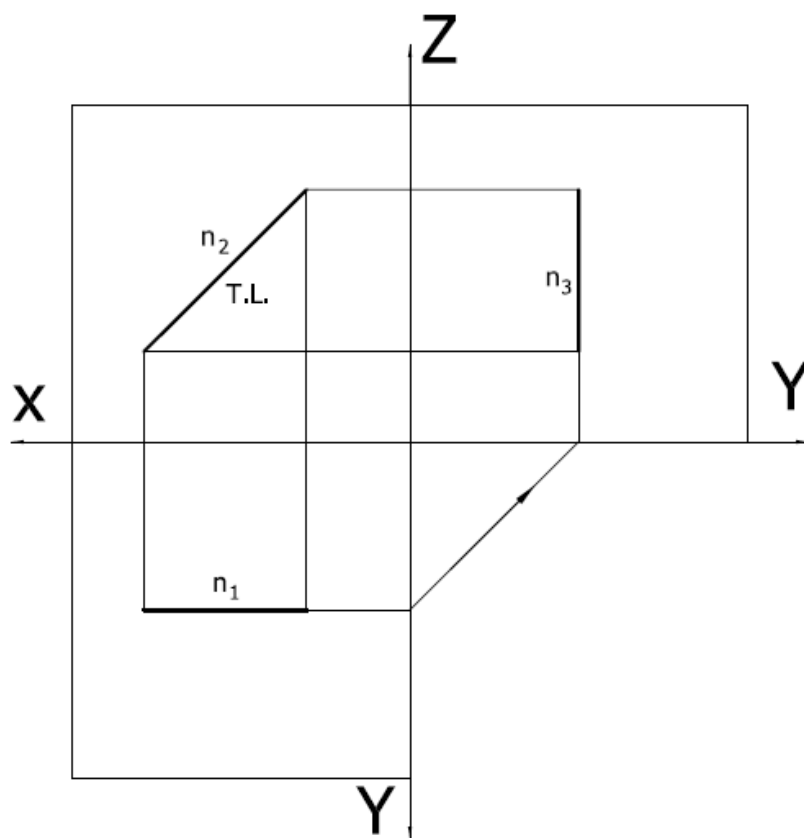
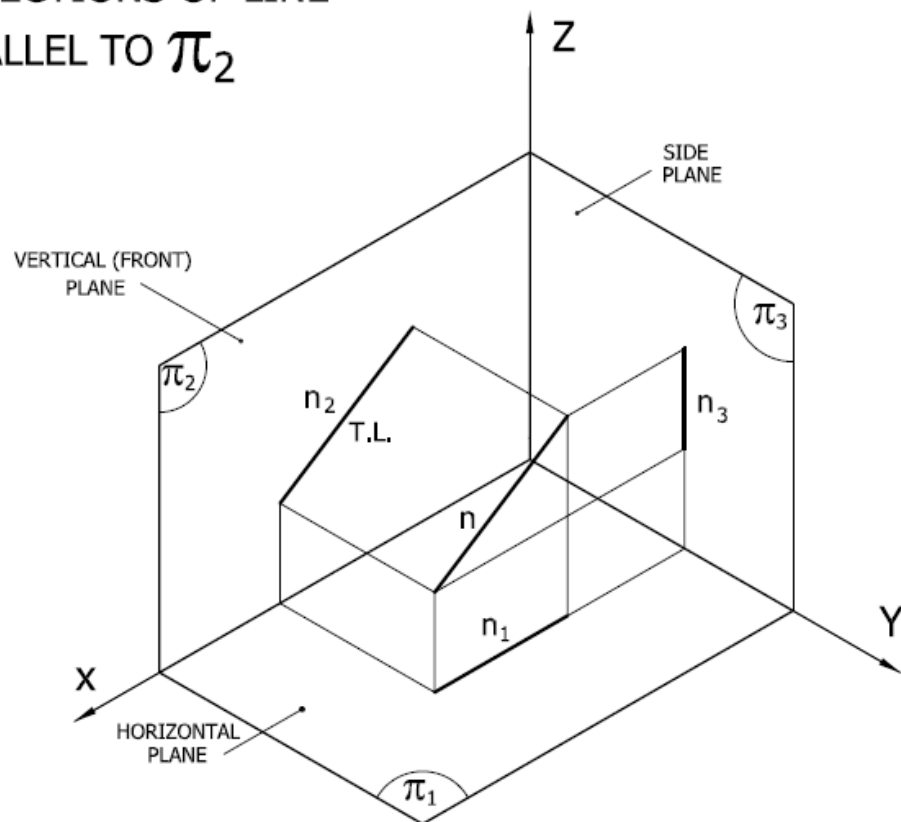
# PROJECTIONS OF LINE PERPENDICULAR TO $\pi_3$



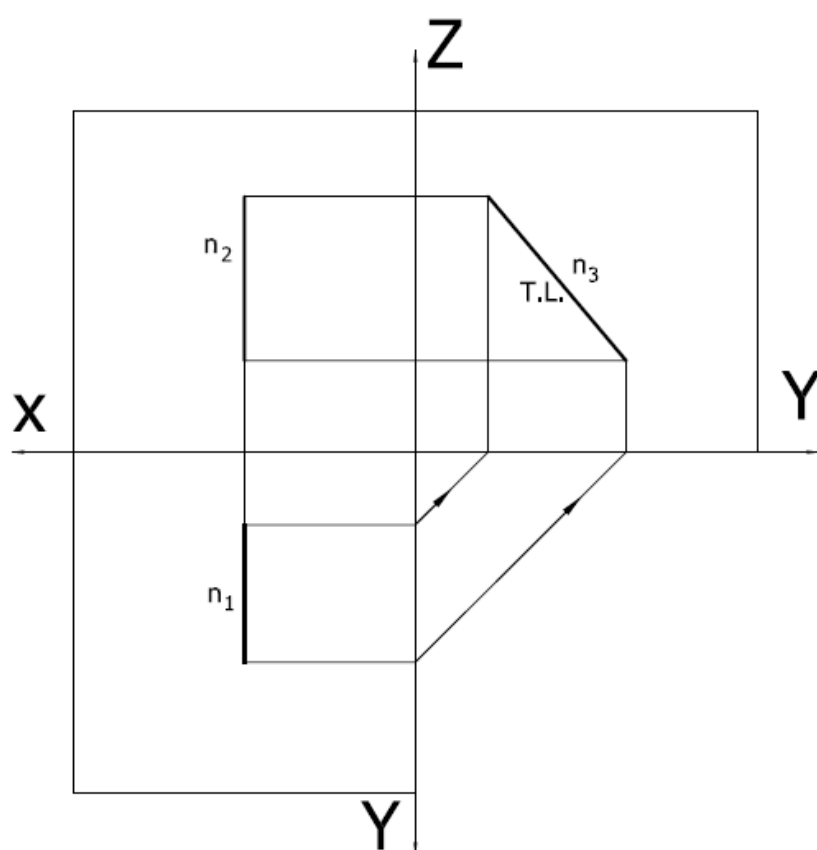
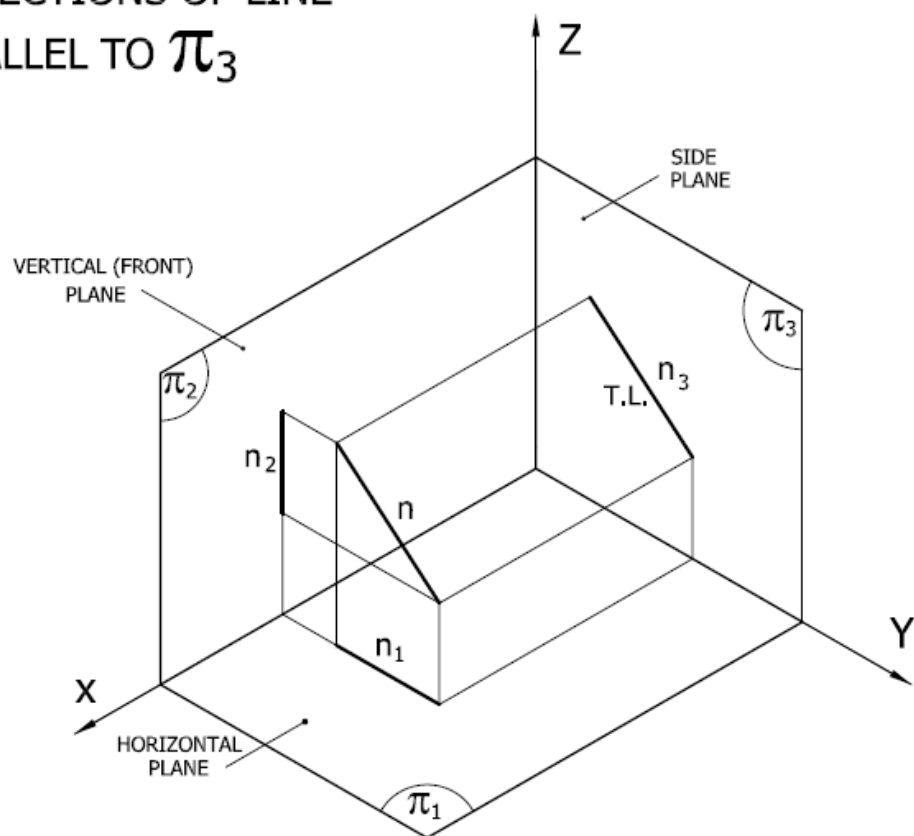
# PROJECTIONS OF LINE PARALLEL TO $\pi_1$



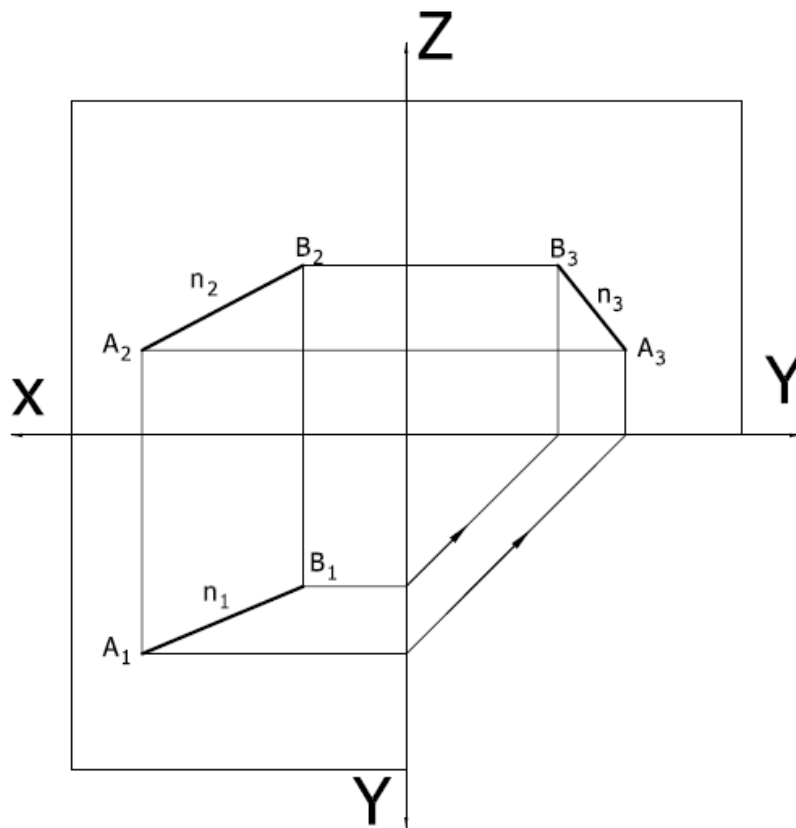
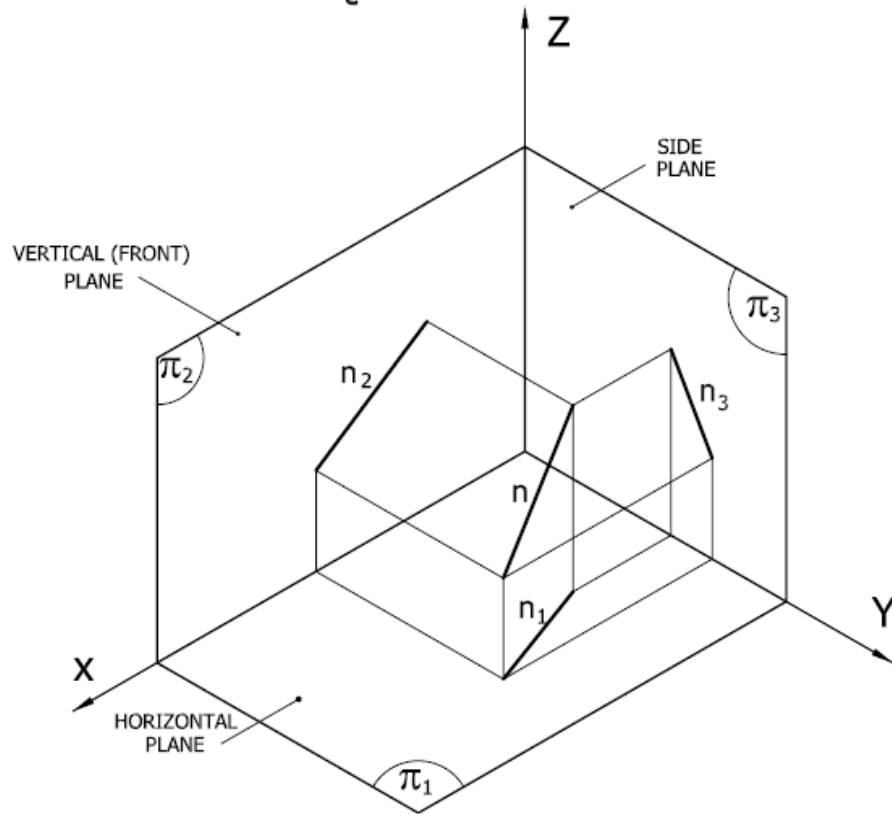
# PROJECTIONS OF LINE PARALLEL TO $\pi_2$



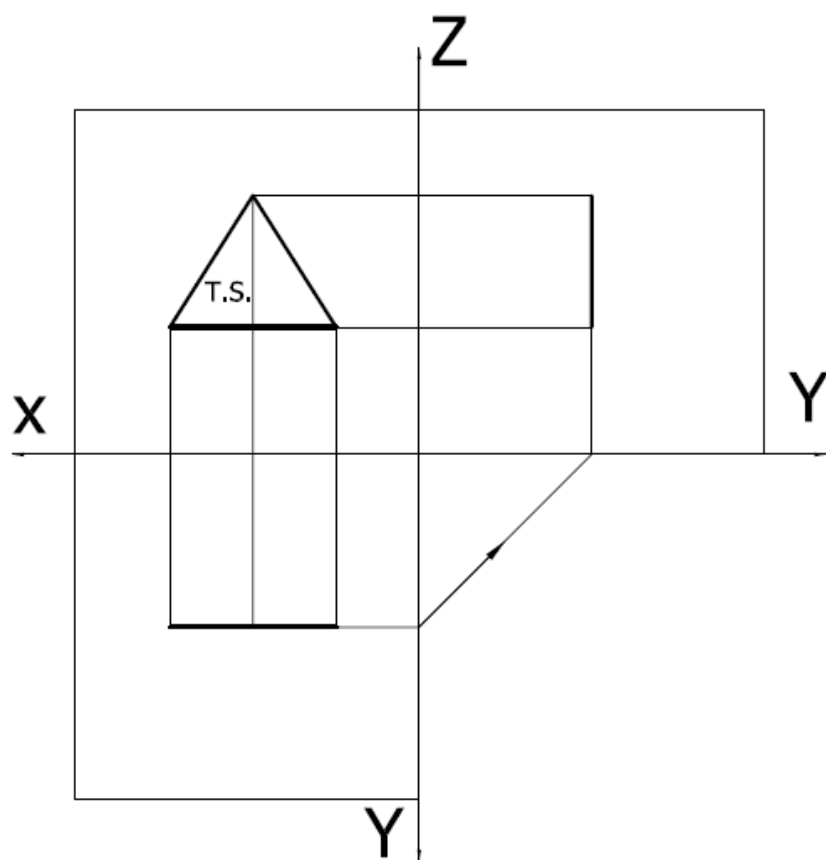
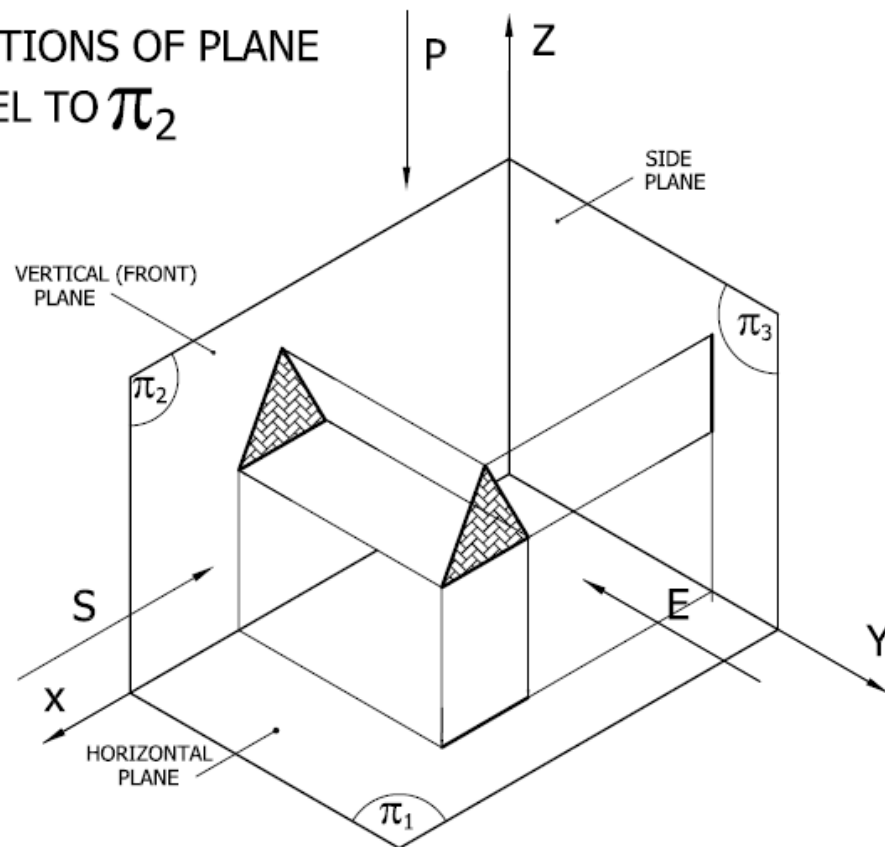
# PROJECTIONS OF LINE PARALLEL TO $\pi_3$



## PROJECTIONS OF OBLIQUE LINE



# PROJECTIONS OF PLANE PARALLEL TO $\pi_2$















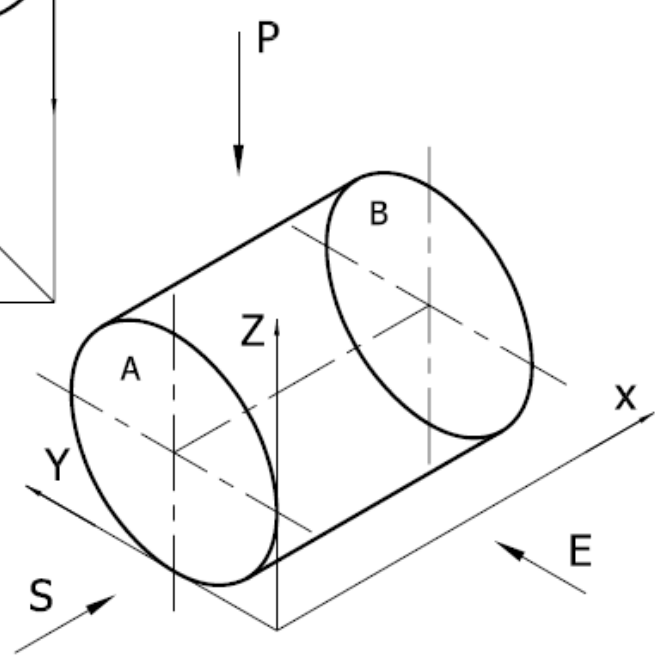
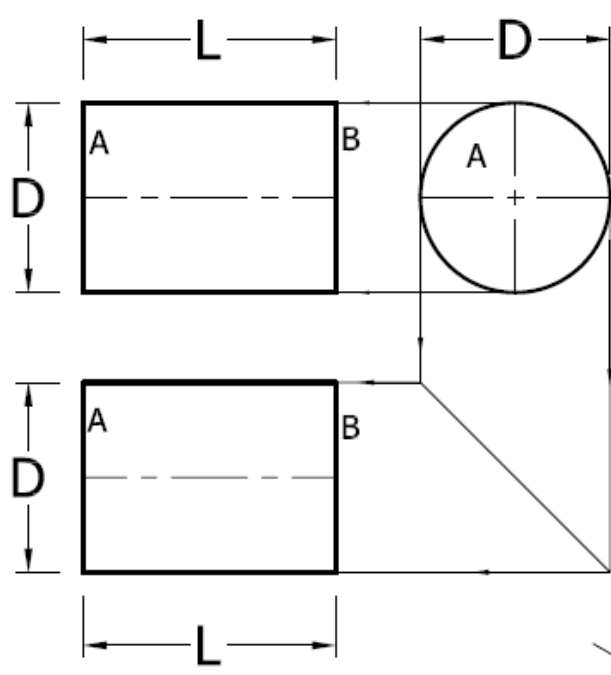
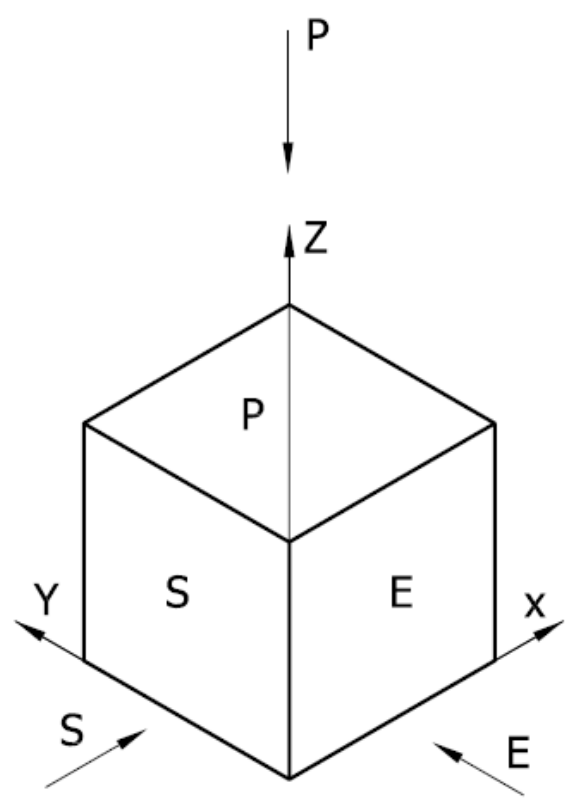
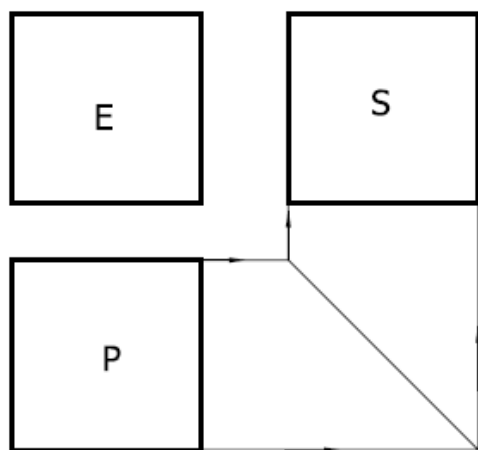


## Projection of Three Dimensions Objects

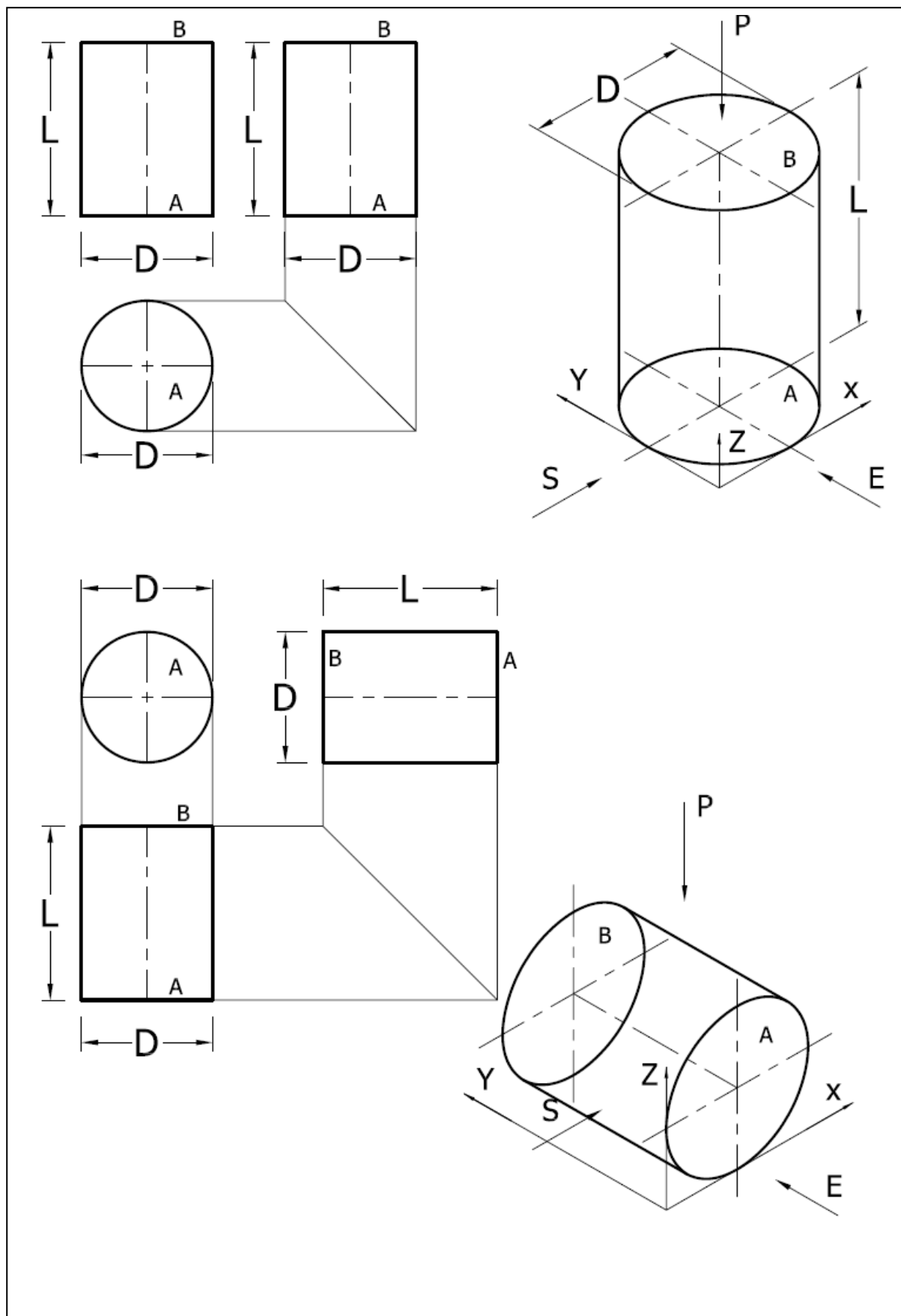
Three dimensions object is formed of a group of elements containing points, lines and surfaces such as planes and solids such as cubes and cylinders. The complete projection is obtained by projecting every element and doing the correct projection of the connections between them. In this section, the elementary basic surfaces as well as complex 3-D objects are projected. The basic surfaces are the cube, cylinder, cone and pyramids. The complex 3-D object can be decomposed into the elementary basic elements that form it. This decomposition is necessary to simplify the method of projection but it is necessary to project the 3-D object after connecting them again.

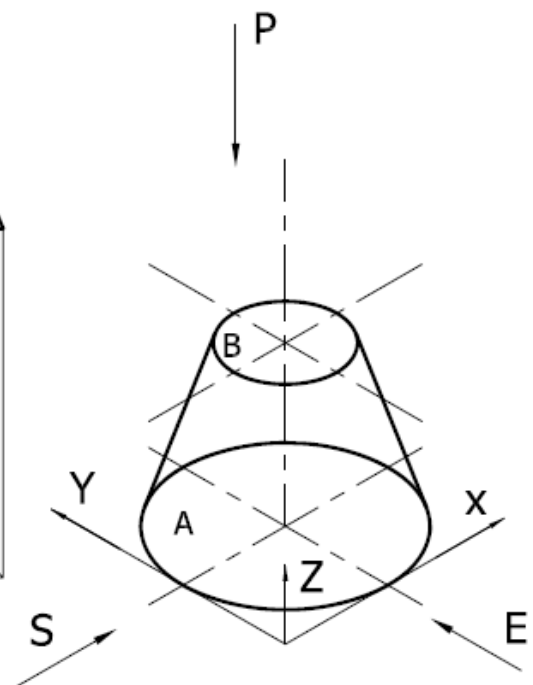
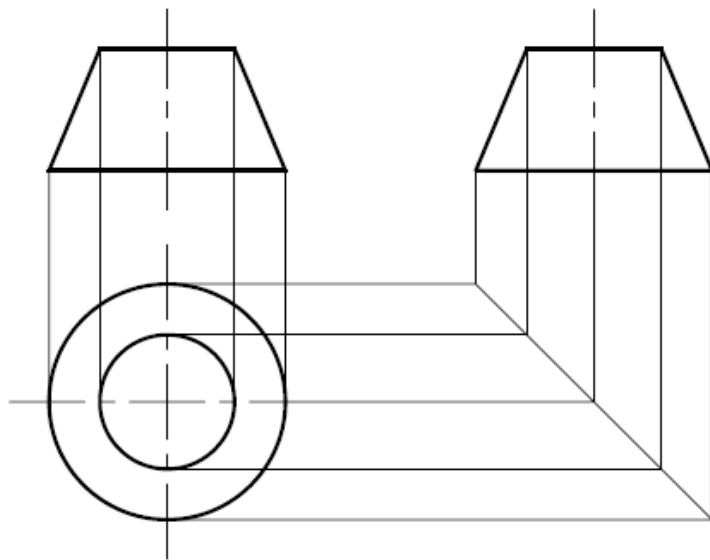
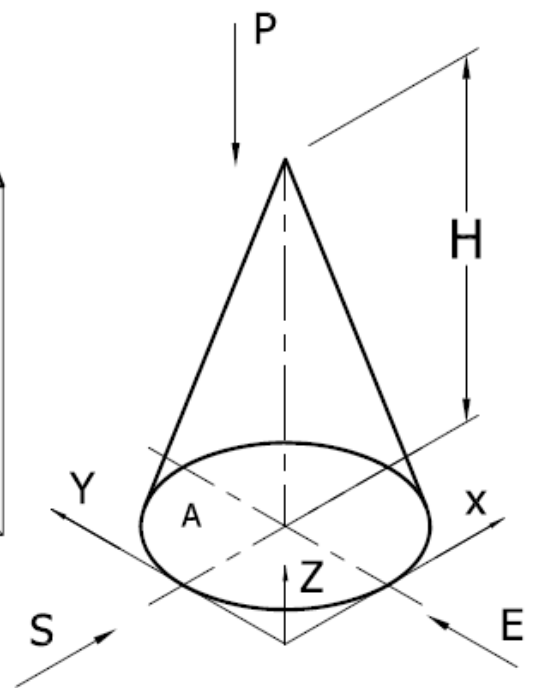
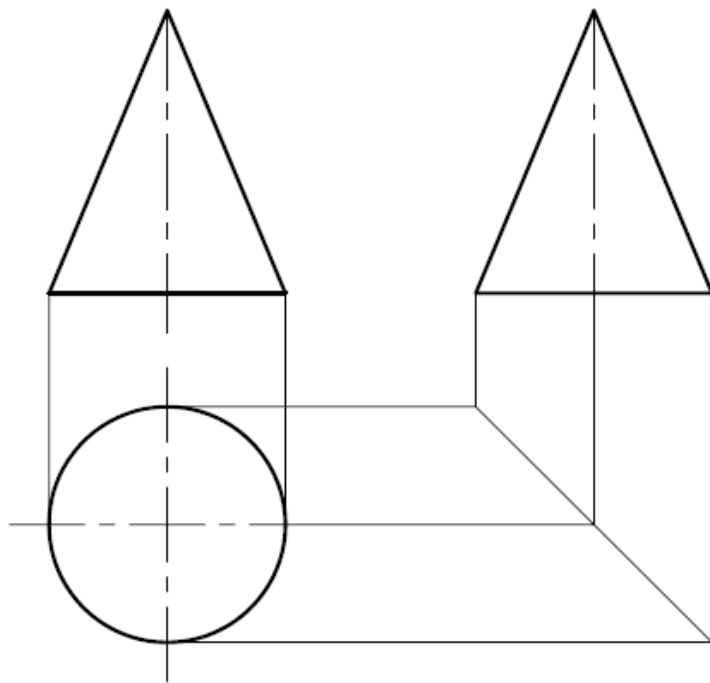
Notes:

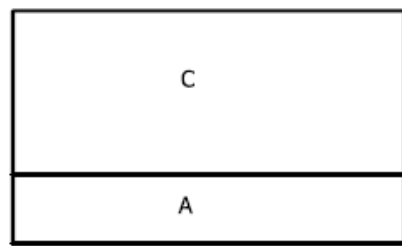
- 1- Line on the 3-D objects or in the produced view represent an edge of a surface, corner of intersection between two surfaces or a limit of surface.
- 2- The invisible lines in the 3-D objects are drawn by hidden lines in the views.
- 3- Closed area in the views or in the 3-D means plane or surface or a union of two surfaces.



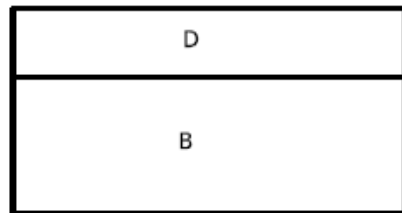




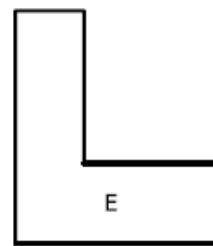




ELEVATION

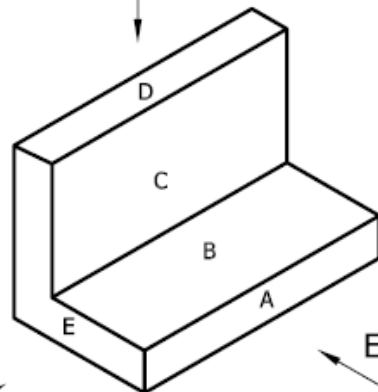


PLAN



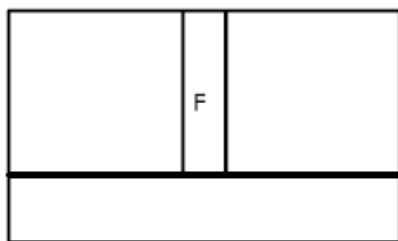
SIDE VIEW

PLAN

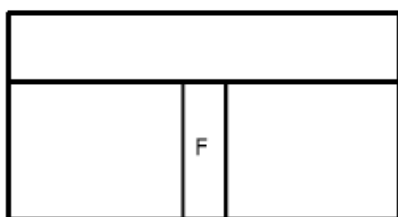


ELEV.

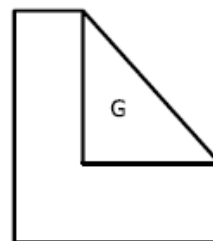
S. V.



ELEVATION

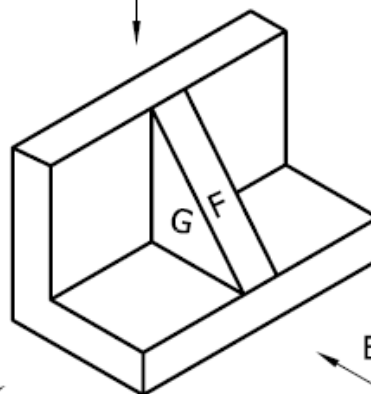


PLAN



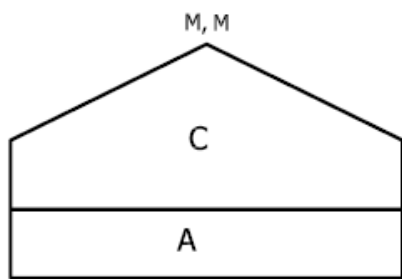
SIDE VIEW

PLAN

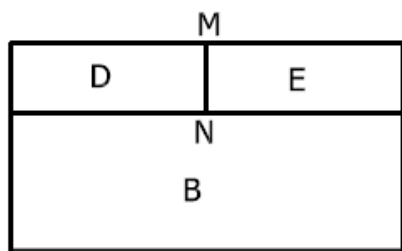


ELEV.

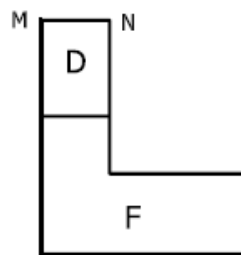
S. V.



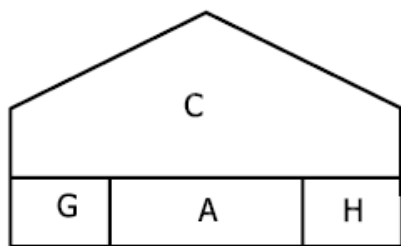
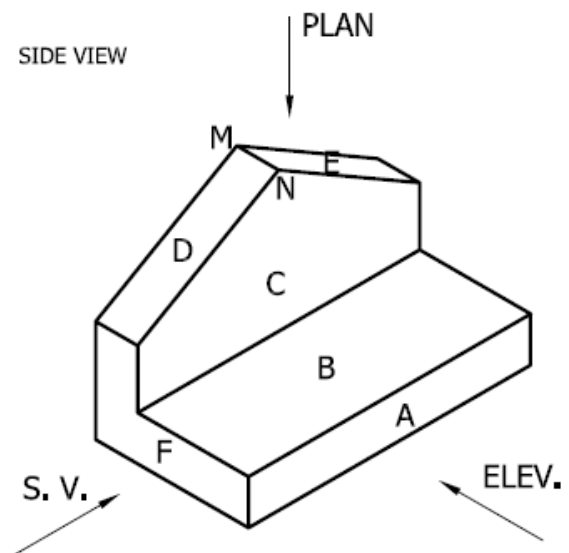
ELEVATION



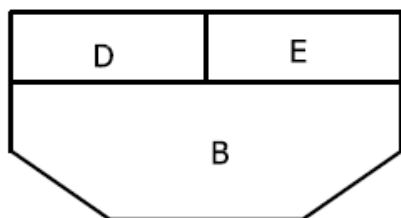
PLAN



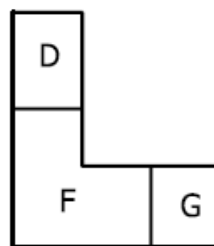
SIDE VIEW



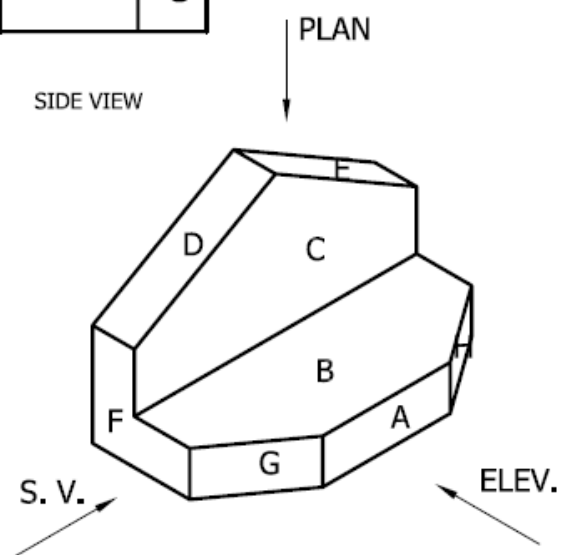
ELEVATION



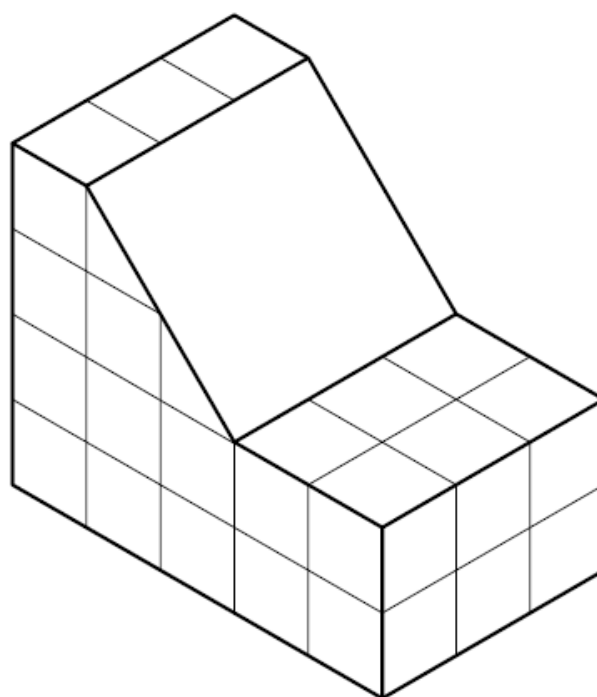
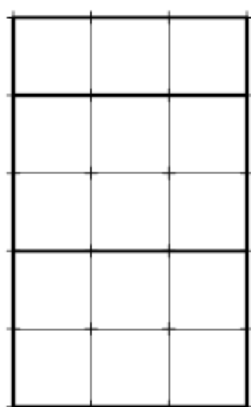
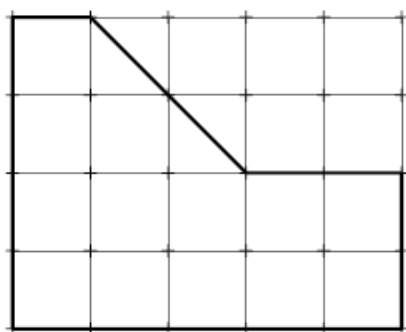
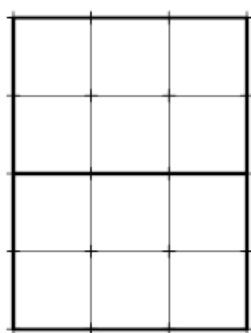
PLAN



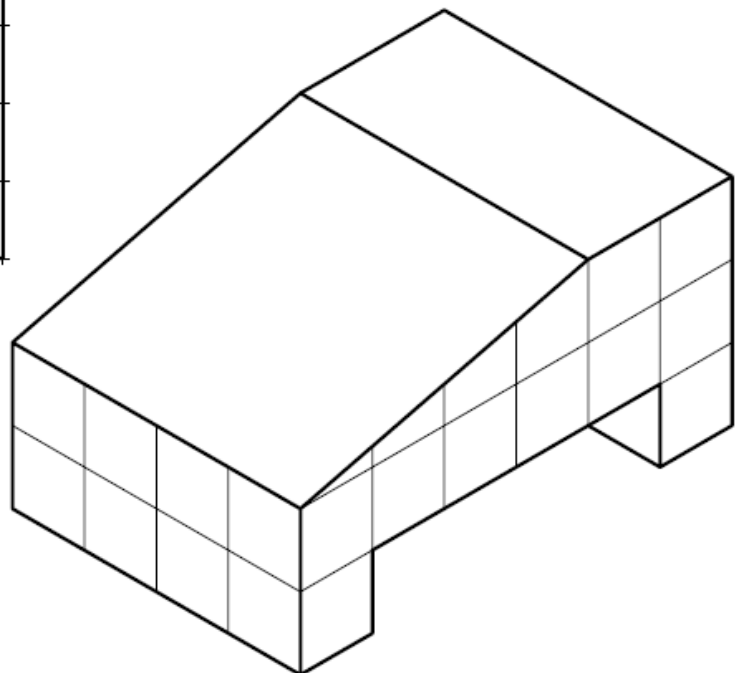
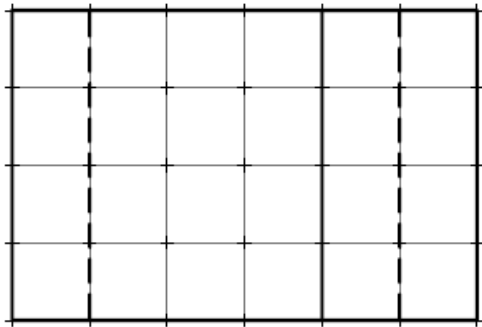
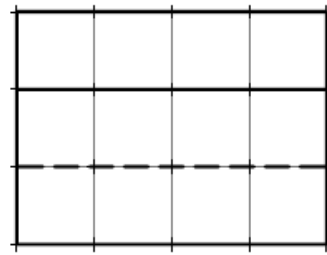
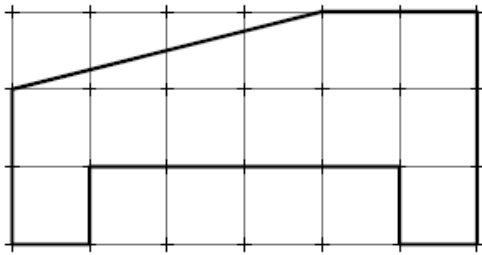
SIDE VIEW



Draw the three views for the given body.

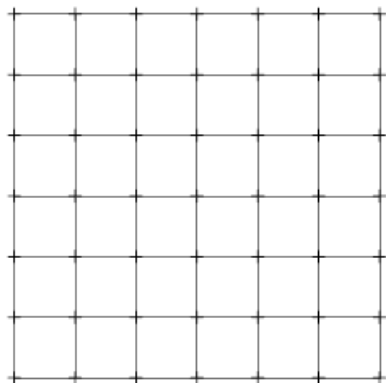


Draw the three views for the given body.

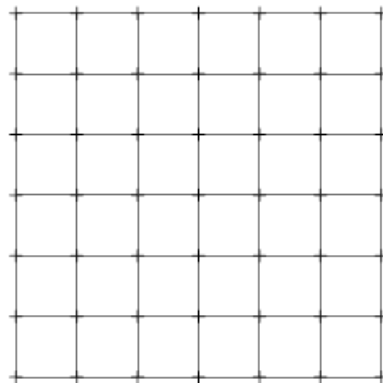


## Assignment 3

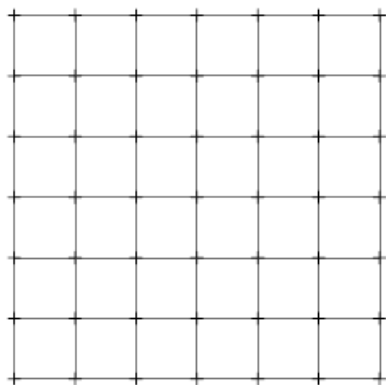
Draw the three views for the given body.



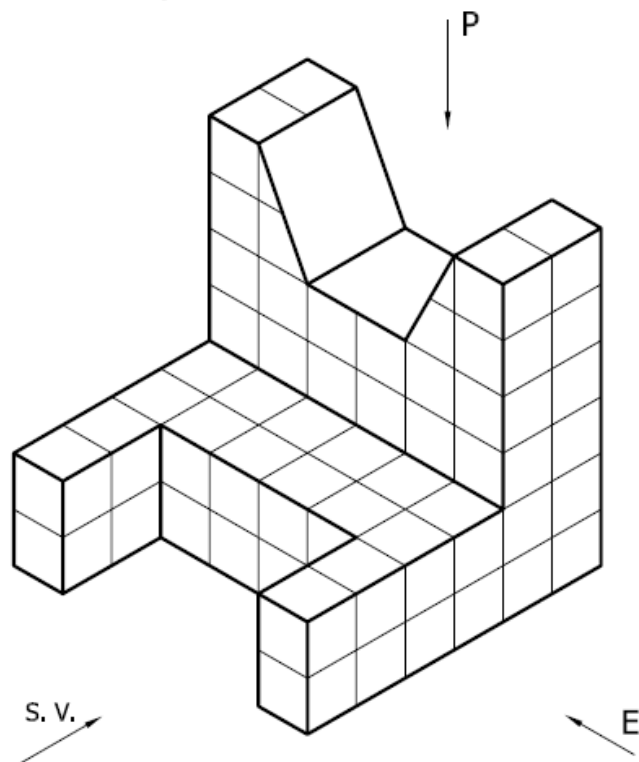
ELEVATION



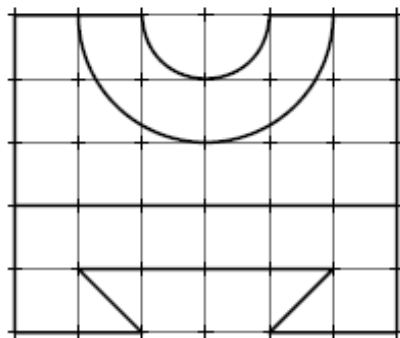
SIDE VIEW



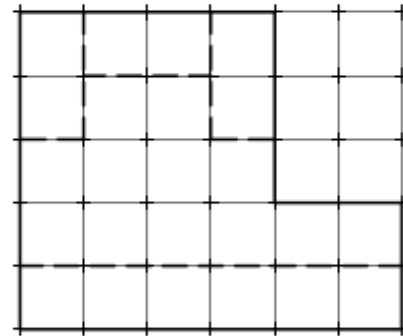
PLAN



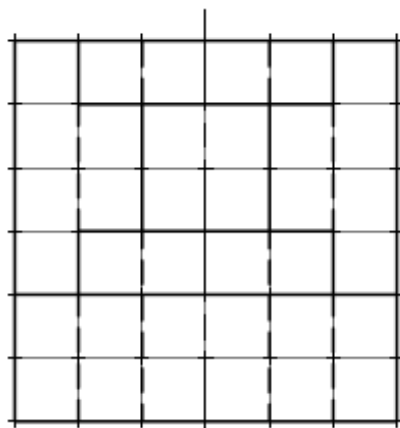
Draw the three views for the given body.



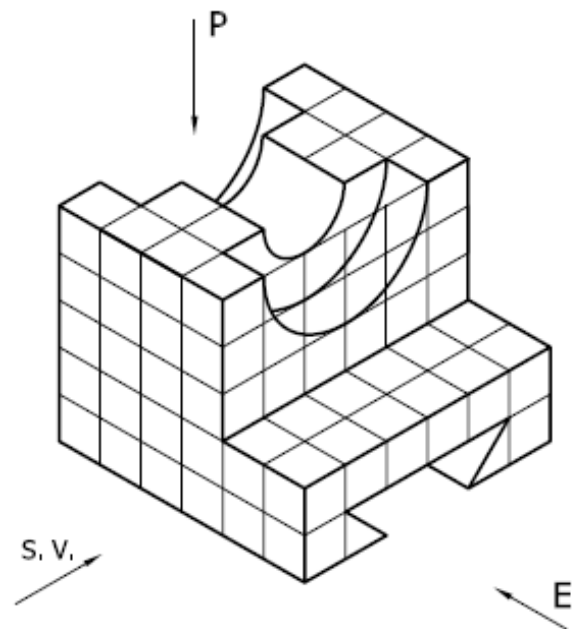
ELEVATION



SIDE VIEW

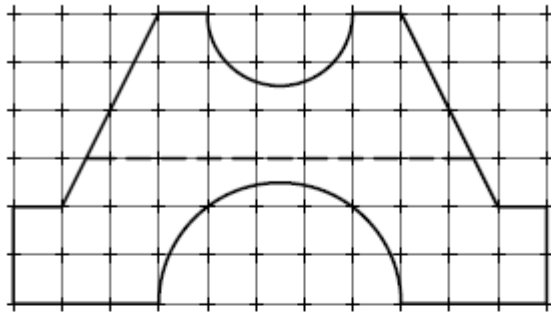


PLAN

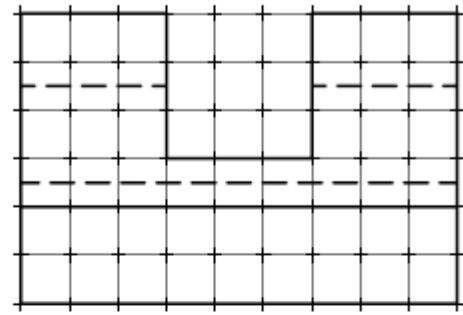




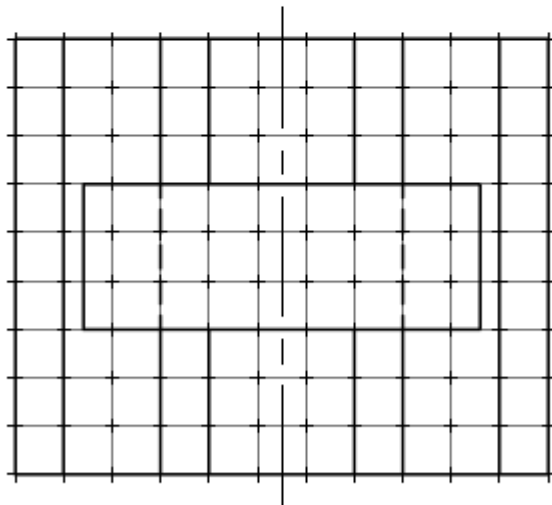
Draw the three views for the given body.



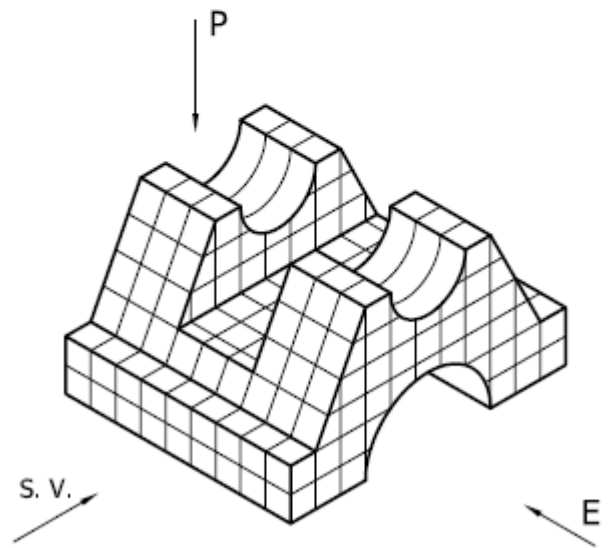
ELEVATION



SIDE VIEW

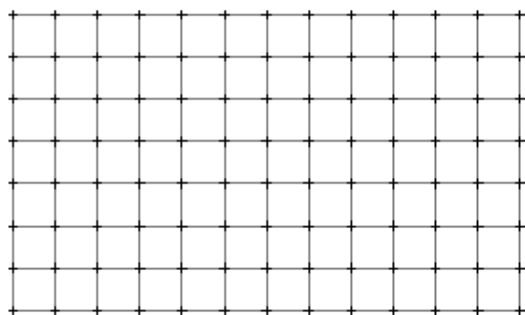


PLAN

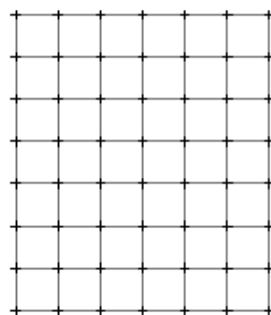


## Assignment 4

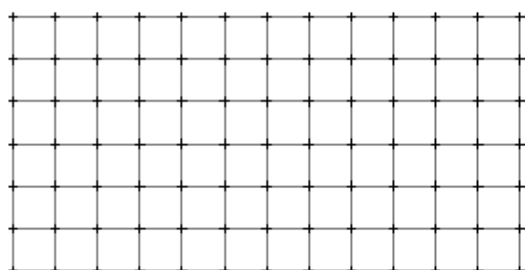
Draw the three views for the given body.



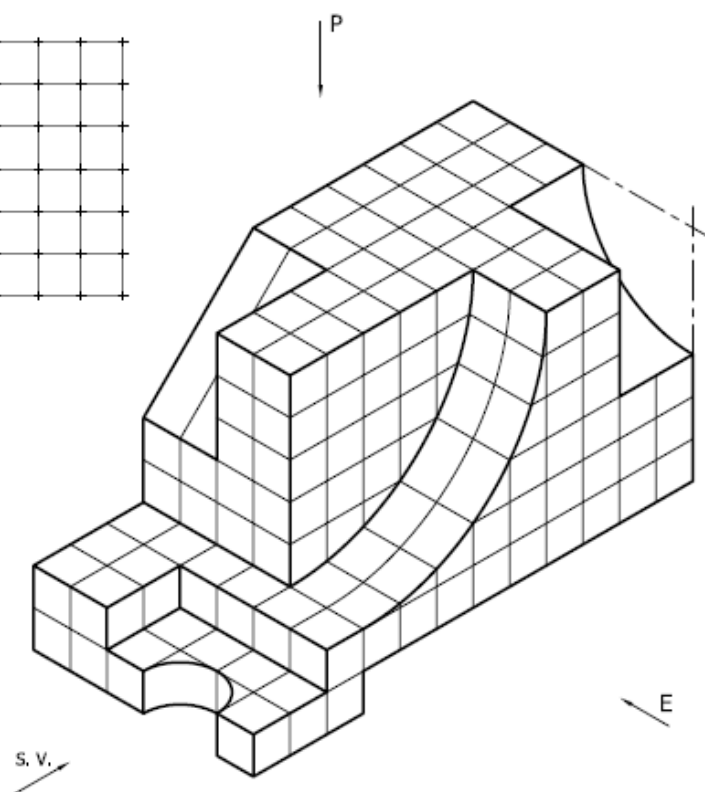
ELEVATION

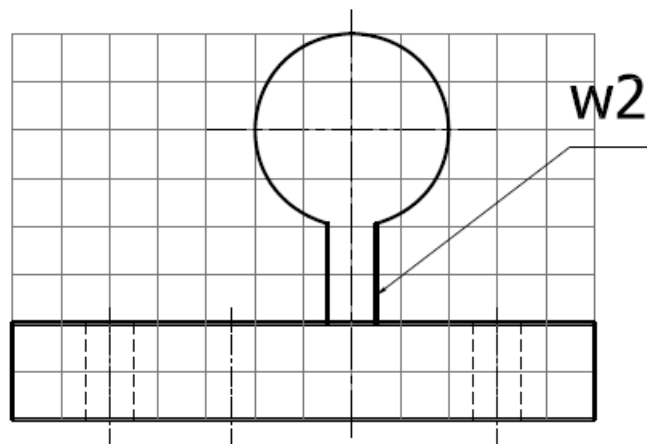


SIDE VIEW

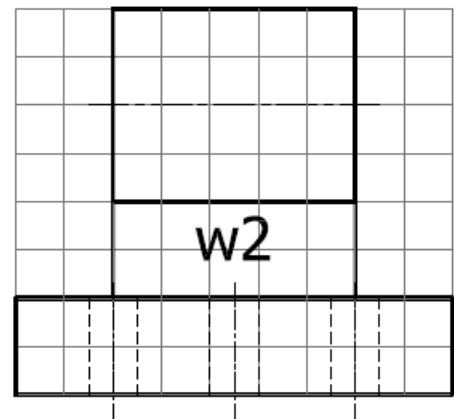


PLAN

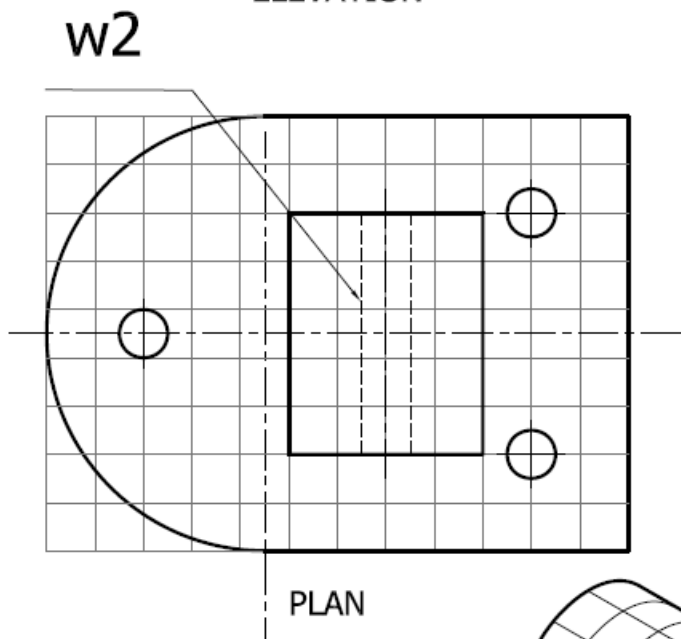




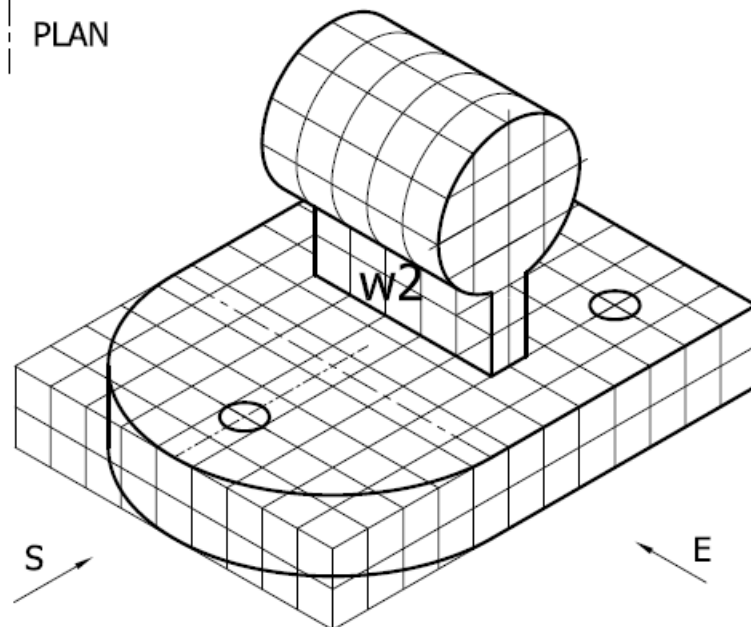
ELEVATION

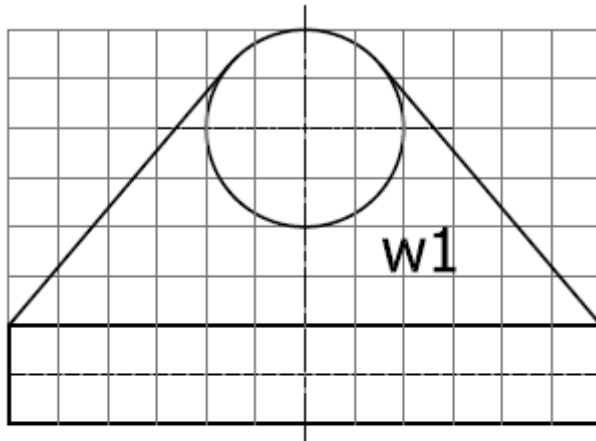


SIDE VIEW

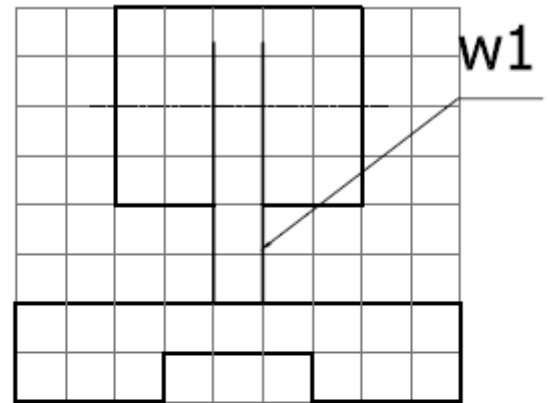


P



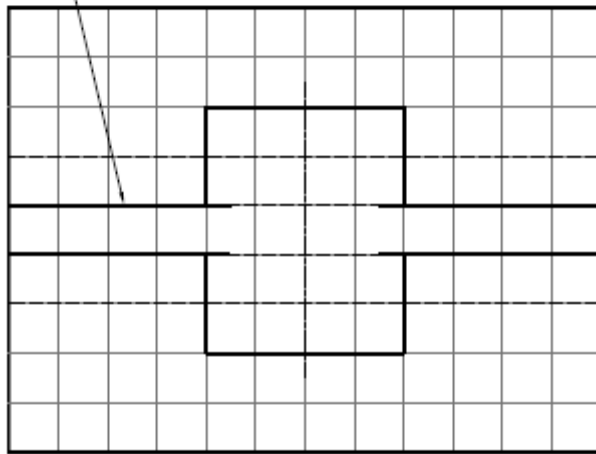


ELEVATION



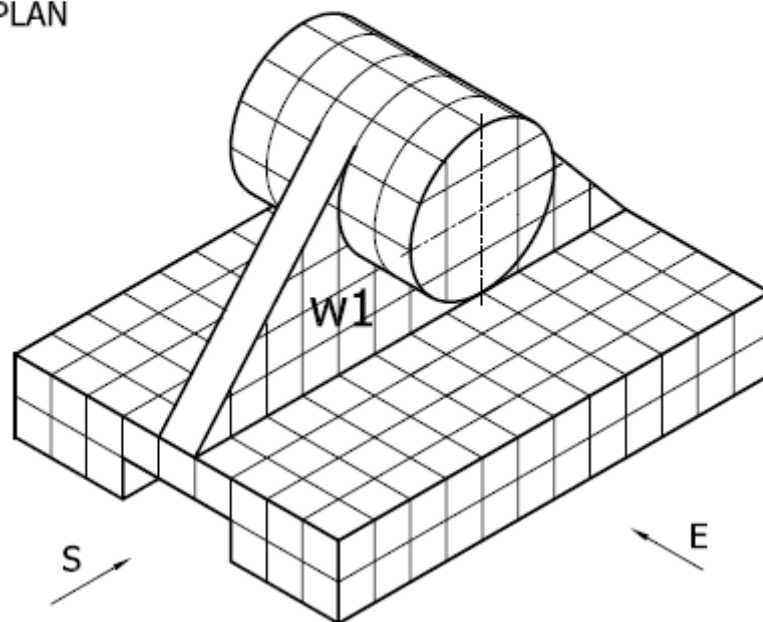
SIDE VIEW

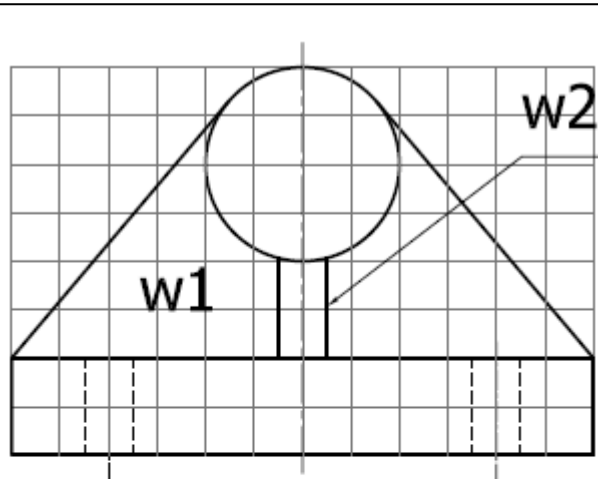
w1



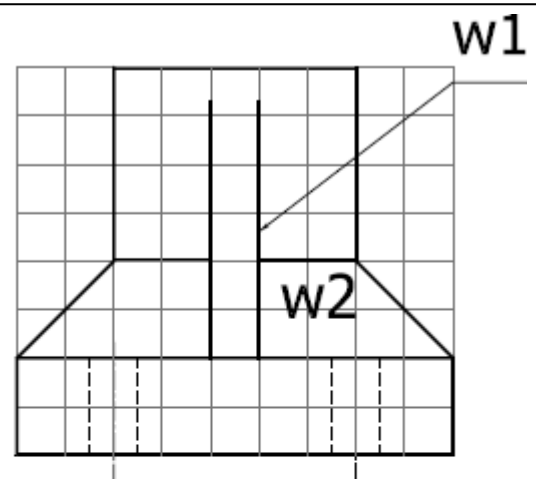
PLAN

P

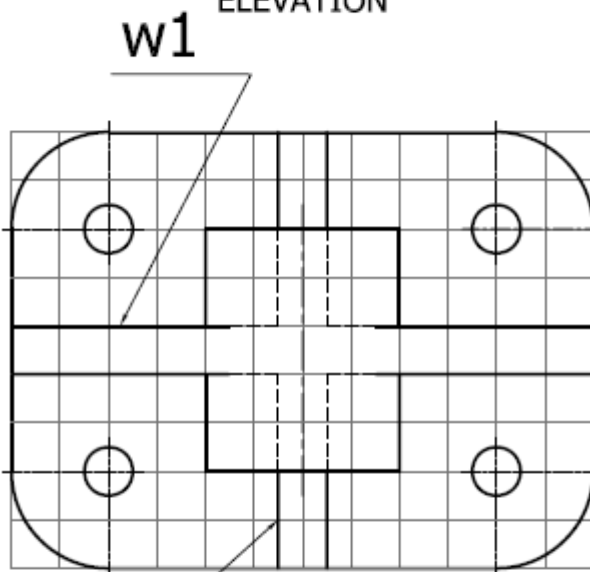




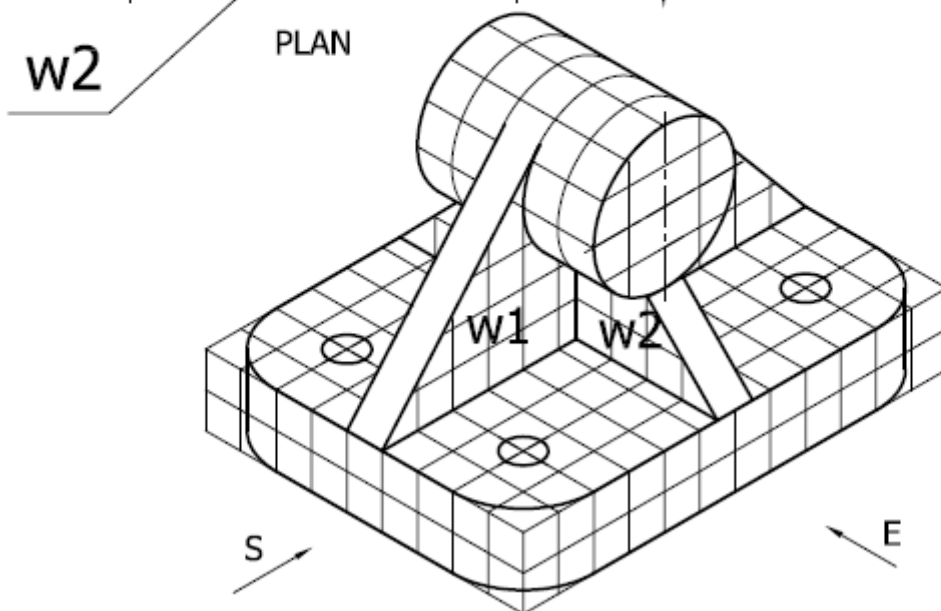
ELEVATION

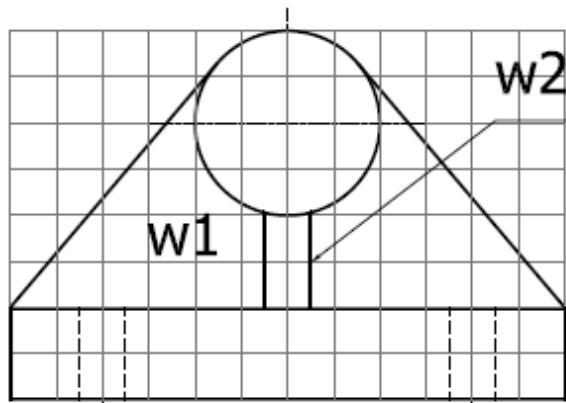


SIDE VIEW

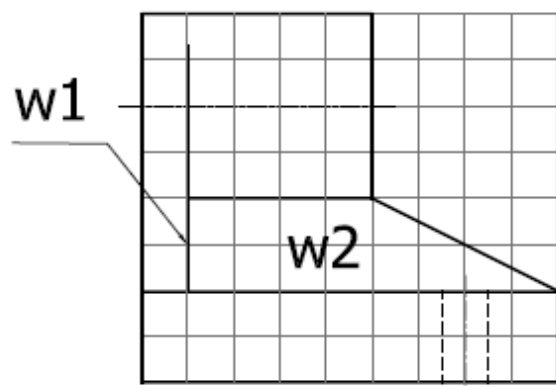


PLAN

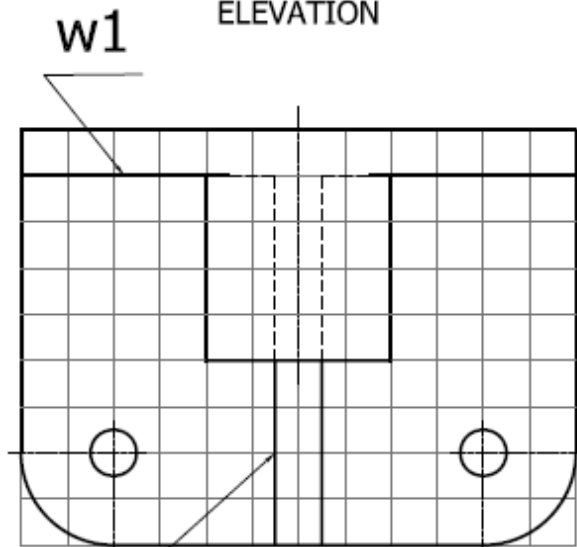




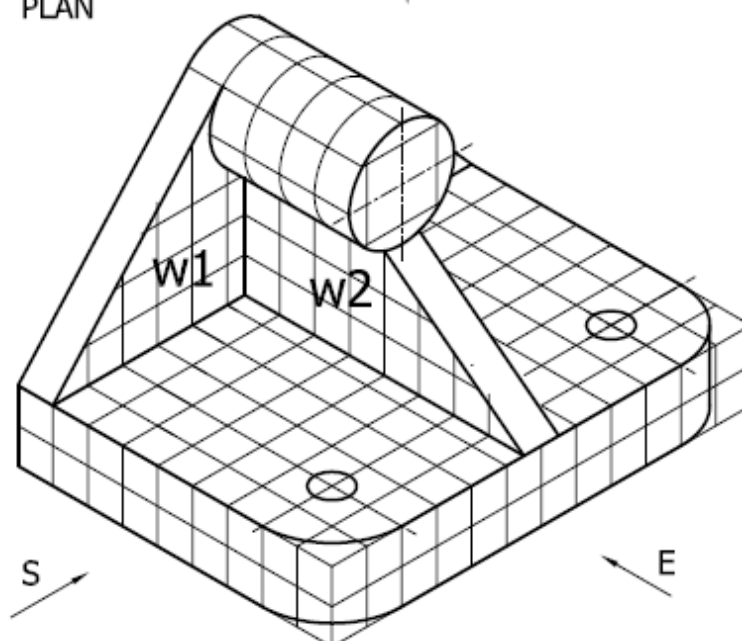
ELEVATION



SIDE VIEW



PLAN



## Missing View

As mentioned before, two views are sufficient to give full description of the 3-D objects. Usually, two views are given, either (Elevation and Side View) or (Elevation and Plan), and it is required to draw the third view.

Reading the drawing is necessary to interpret the actual pictorial shape of the actual object from the given two views. The following outlines simplify the method by which you can get a good imagination of the nonexistent 3-D. Also, by which we will interpret the missed (or third) view.

- 1- Scan all points, lines and surfaces of the objects.
- 2- Define the general idea of the over-all shape of the 3-D object. You may try to refer the object to a group of points, lines, planes, cubes, cylinders, cones, pyramids. Also the object may be decomposed into base like Box, basic parts and connectors like webs. Basic parts can be divided into basic elements.
- 3- Project every part individually and remember to correct the joints between them to form the entire 3-D object. Re-project any detail or connection that was not clear at your first trial of scanning or imagination of the object.

The following examples illustrate the above mentioned method. In each example, two views are given and the third view is required. The examples are divided into three parts:

Part 1: demonstrates simple objects with holes

Part 2: demonstrates simple combined objects

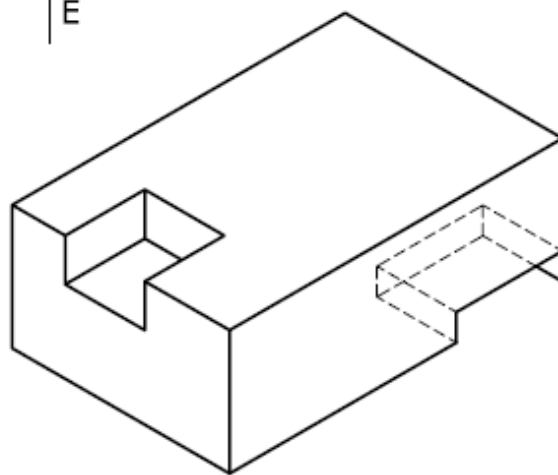
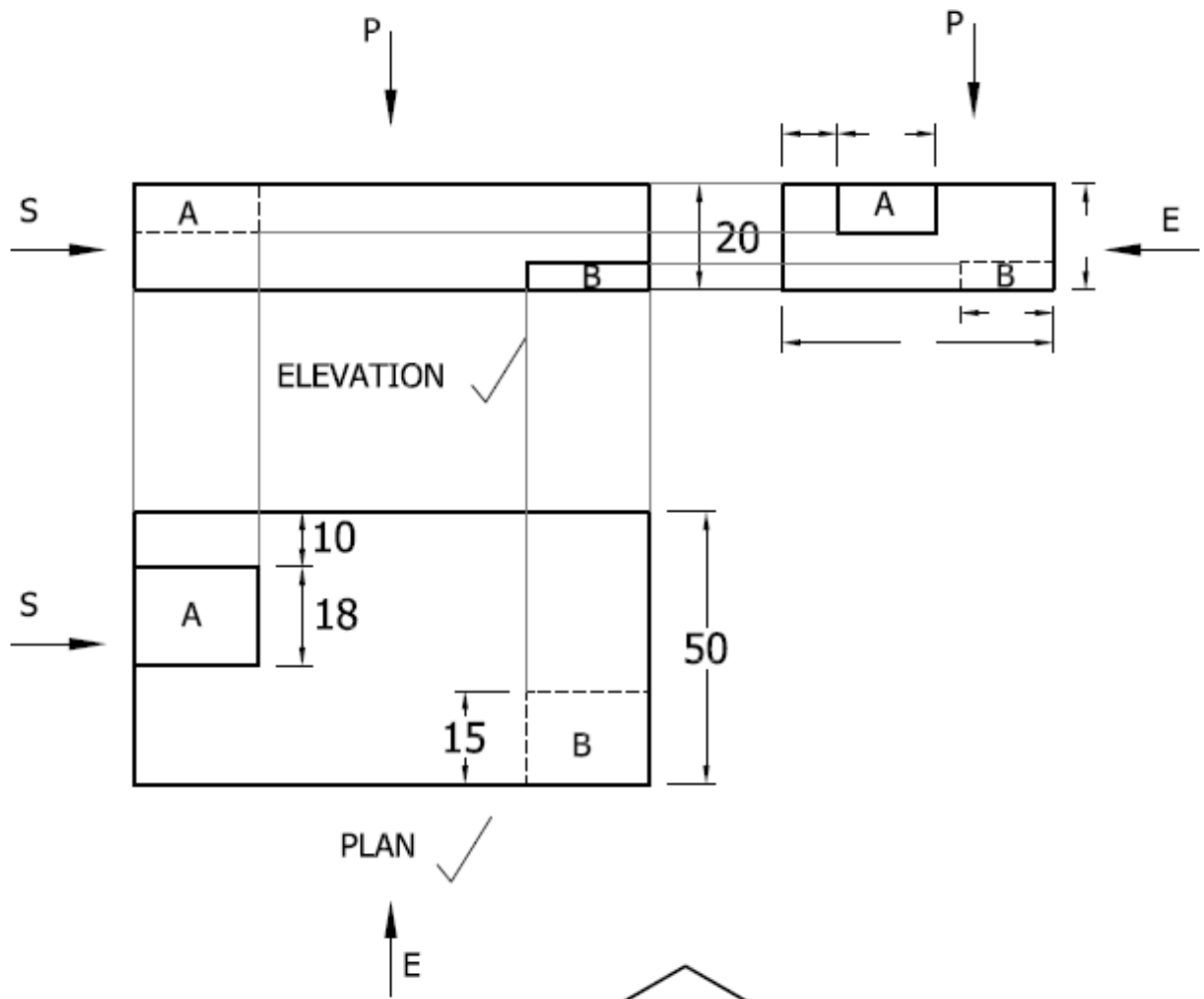
Part 3: demonstrates more complex objects

## Part 1

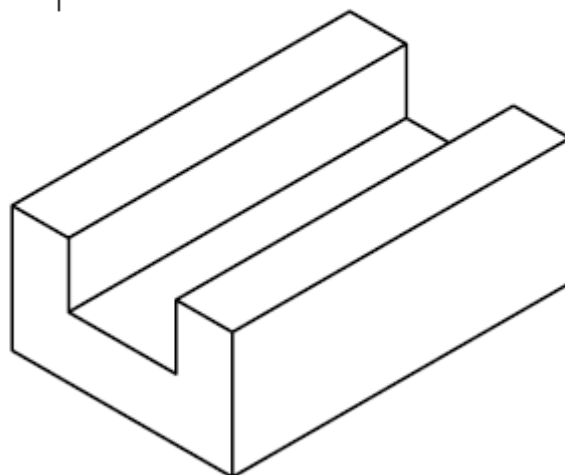
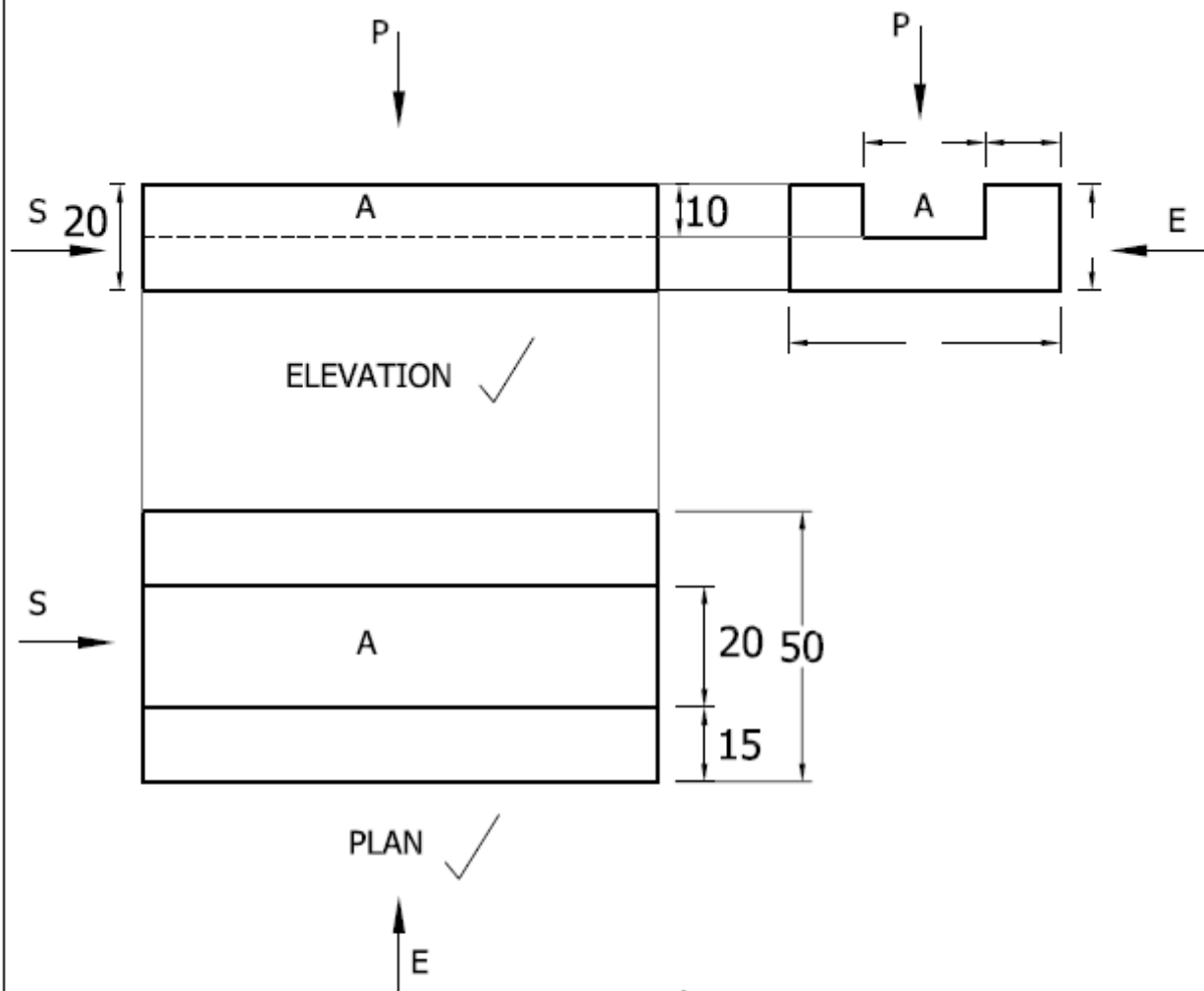
### Simple objects with holes



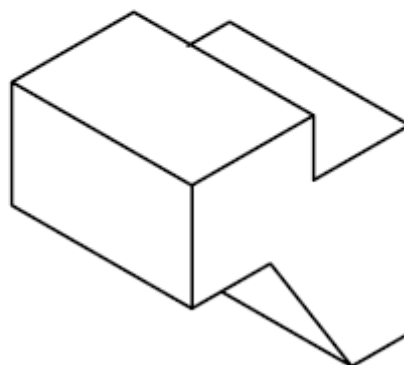
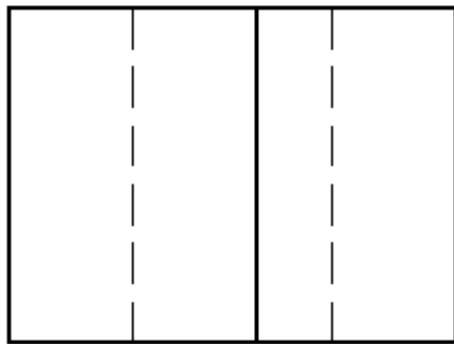
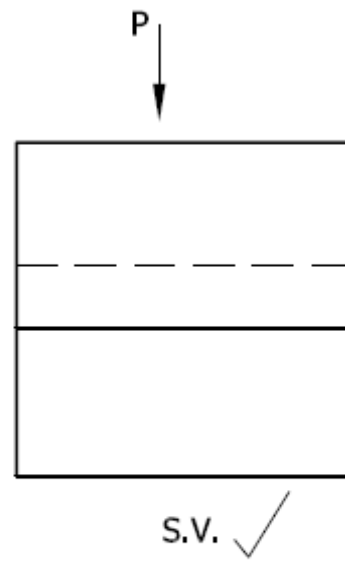
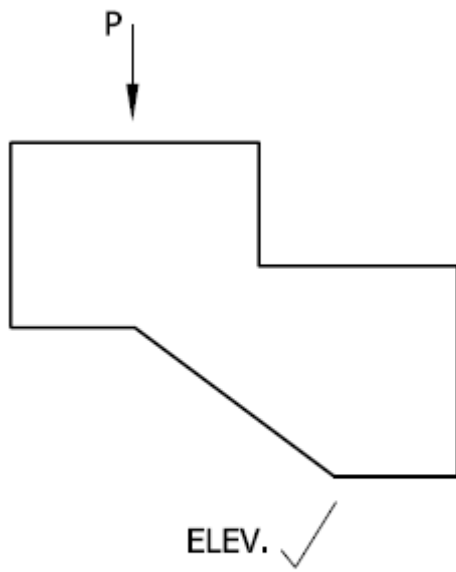
For the given Elevation and Plan, draw the Side View



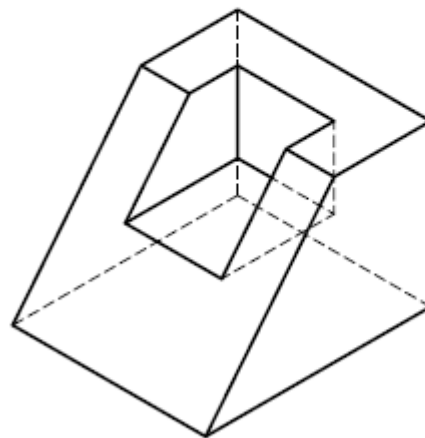
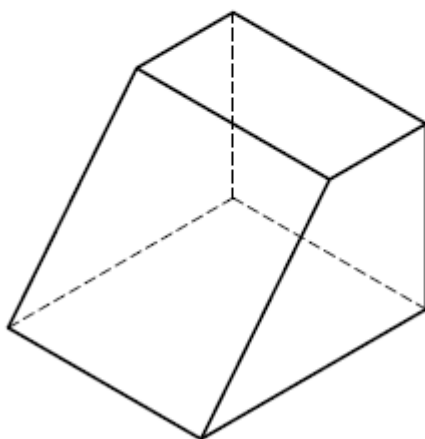
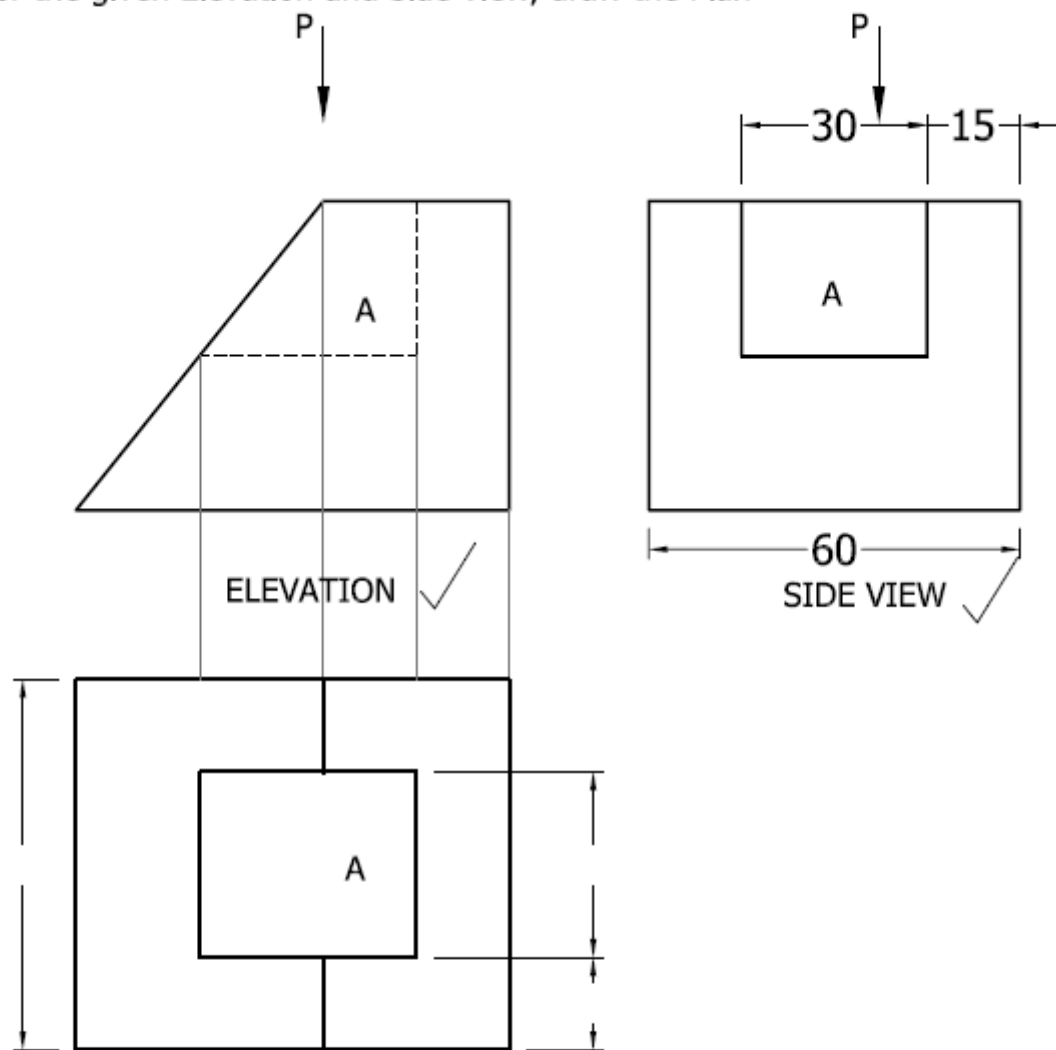
For the given Elevation and Plan, draw Side View



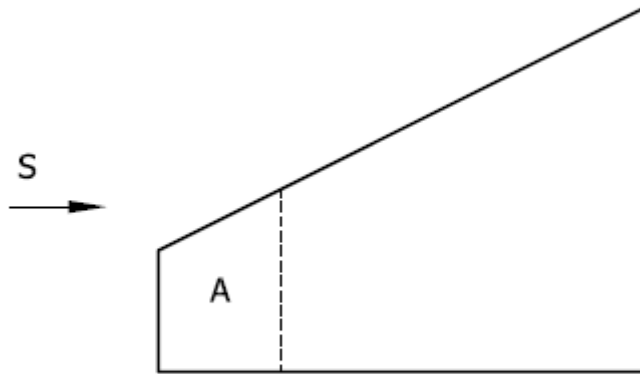
For the given Elevation and Side View, draw the Plan



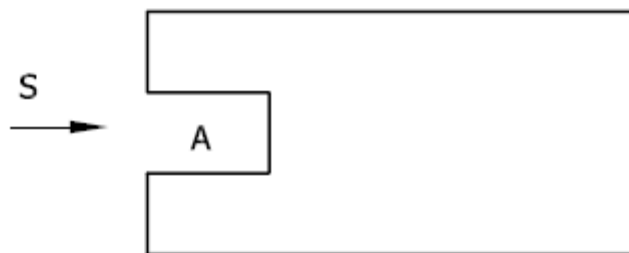
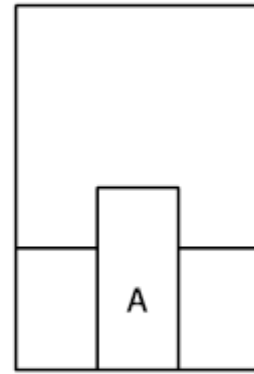
For the given Elevation and Side View, draw the Plan



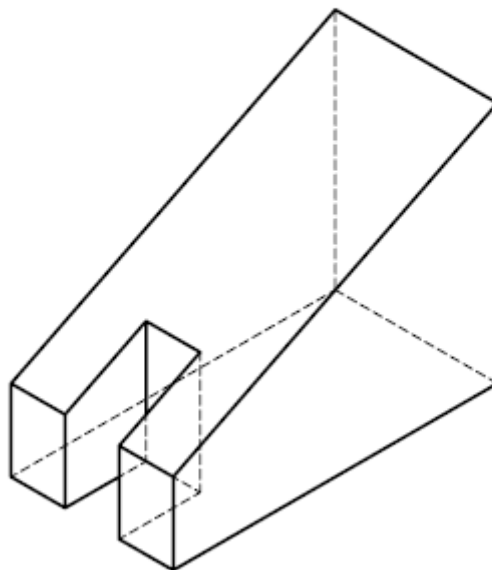
For the given Elevation and Plan, draw the Side View



ELEVATION ✓

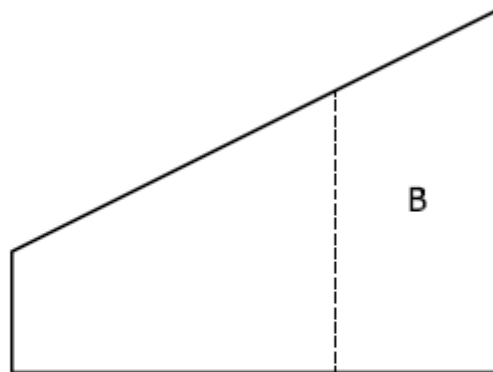


PLAN ✓

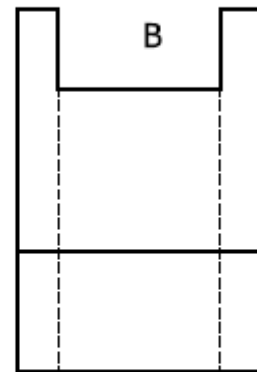


For the given Elevation and Plan, draw the Side View

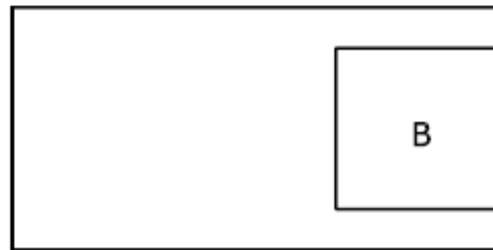
S  
→



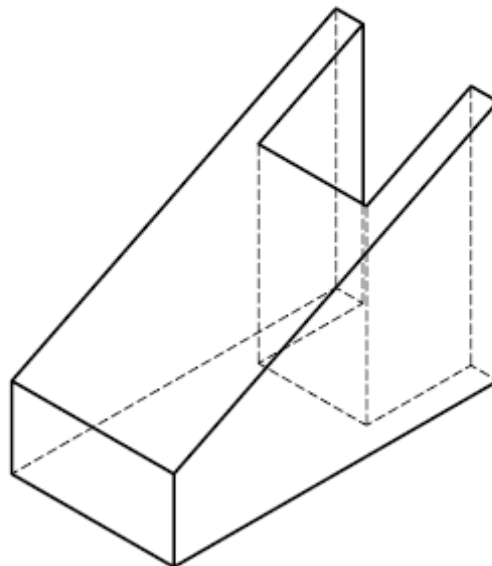
ELEVATION ✓



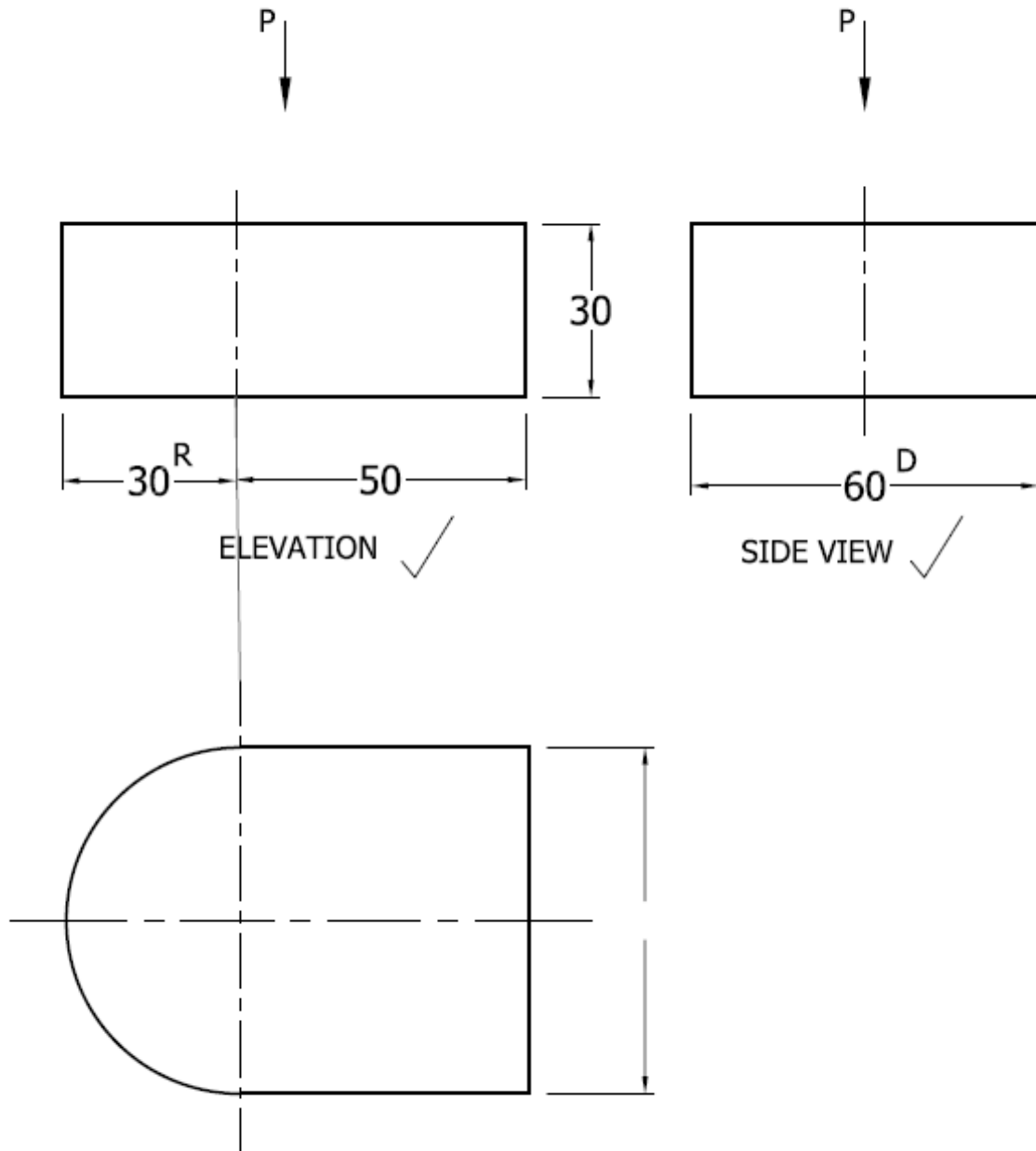
S  
→



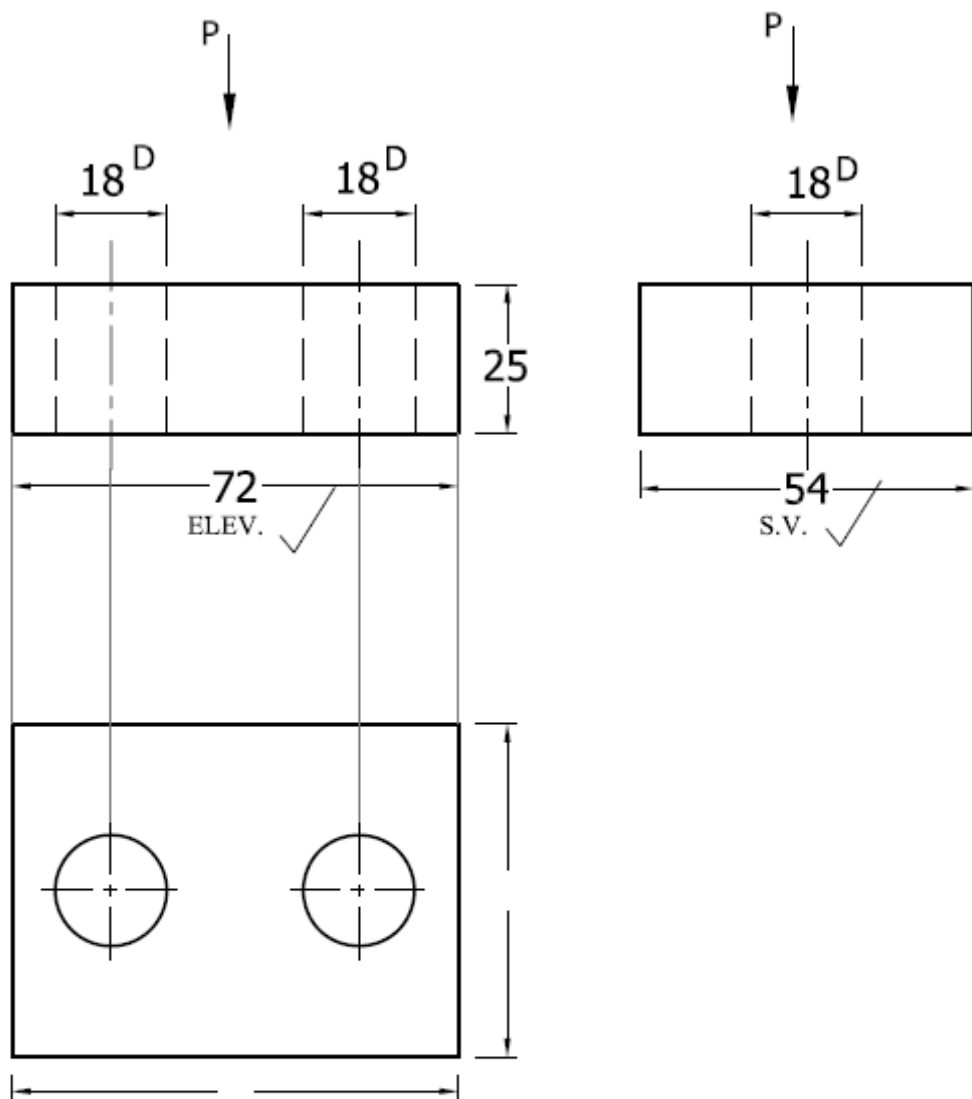
PLAN ✓



For the given Elevation and Side View, draw the Plan

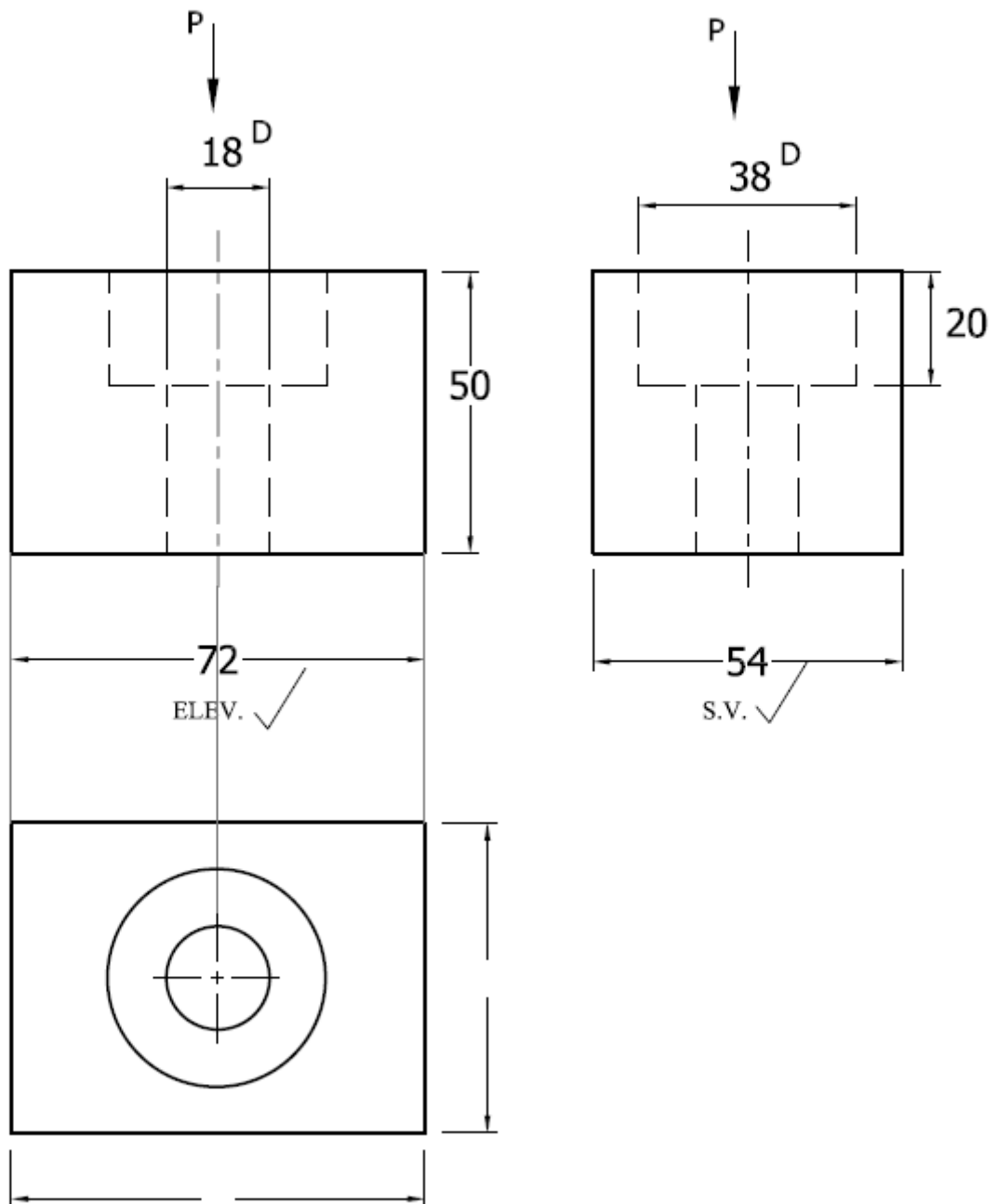


For the given Elevation and Side View, draw the Plan

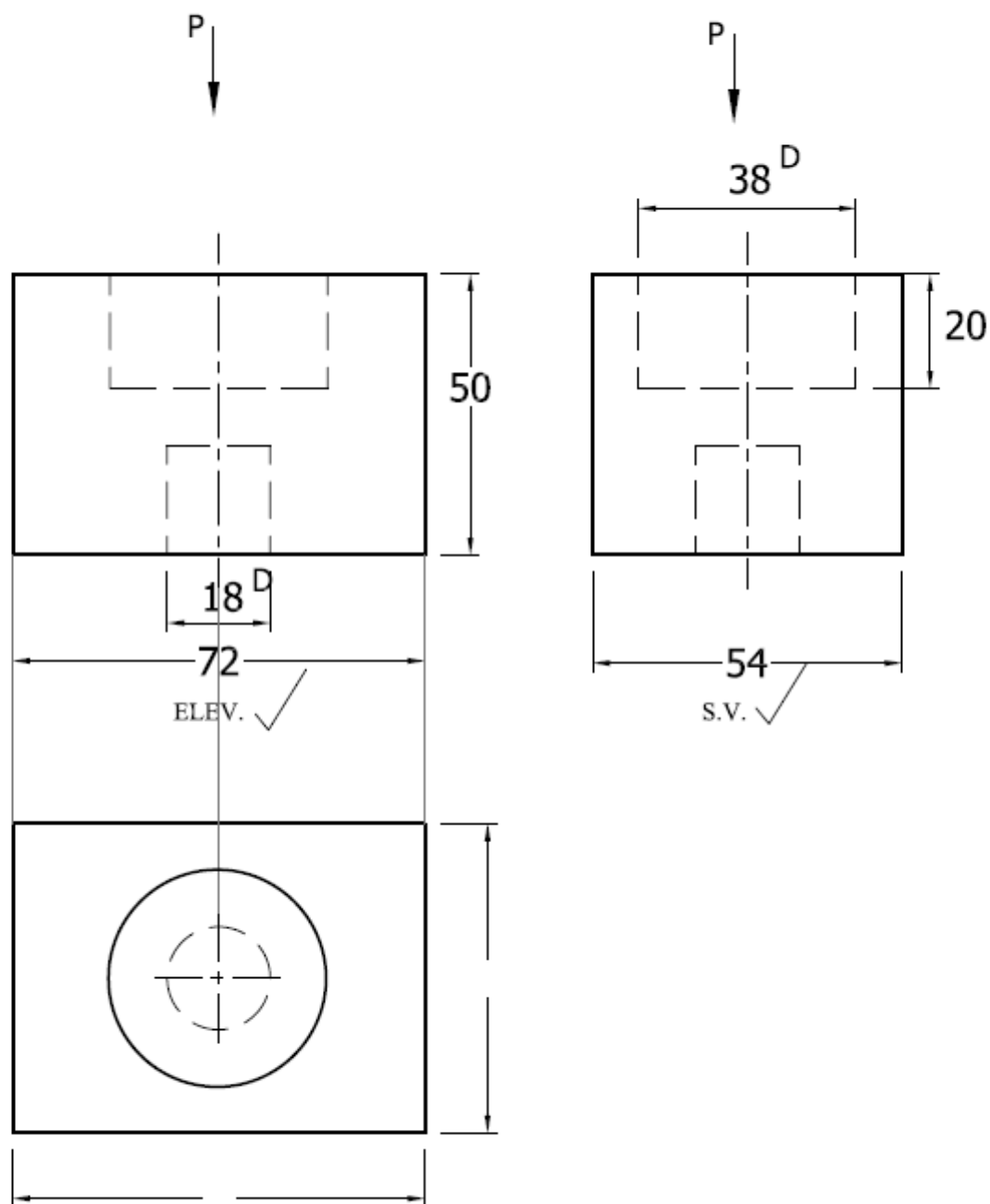




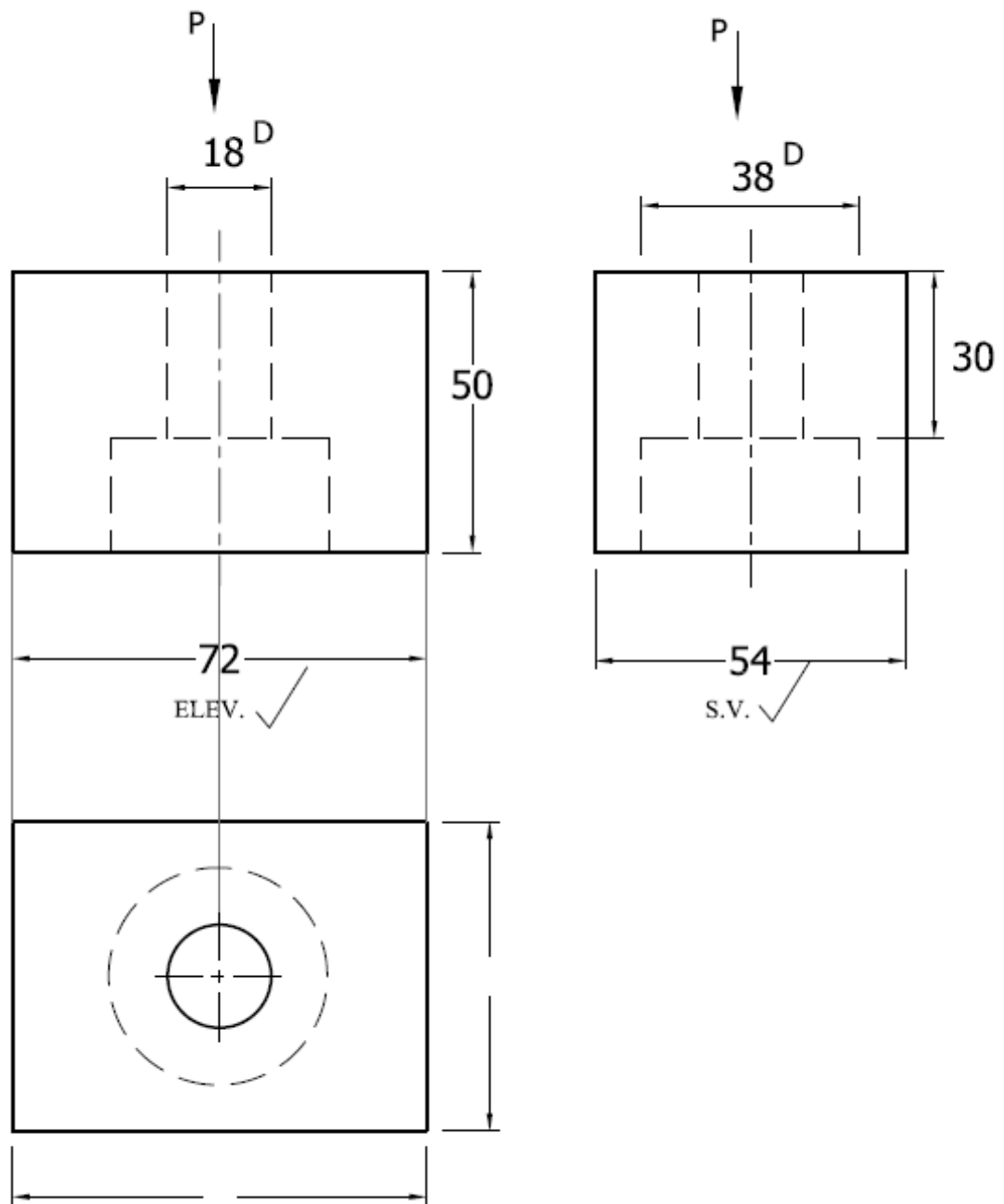
For the given Elevation and Side View, draw the Plan



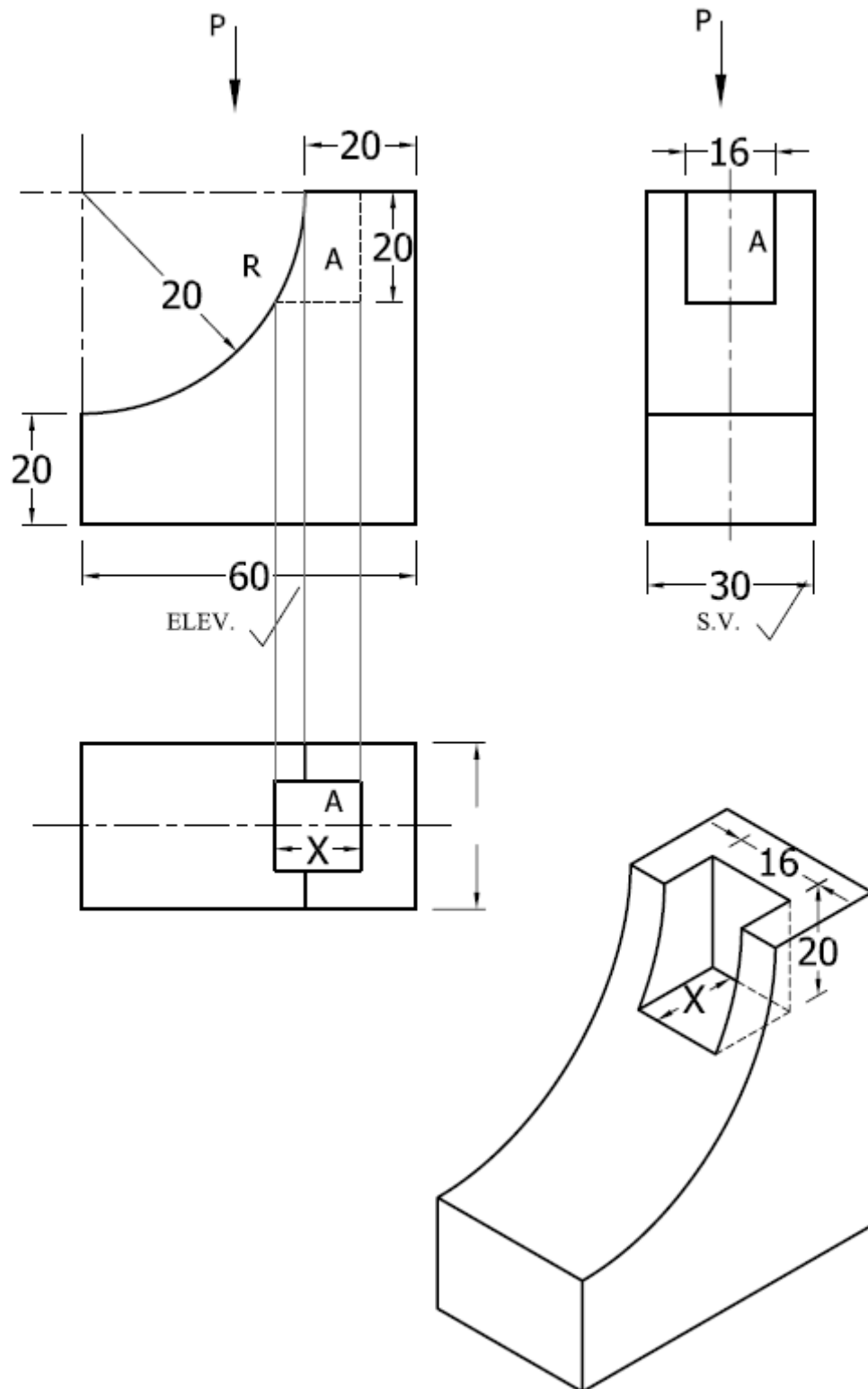
For the given Elevation and Side View, draw the Plan



For the given Elevation and Side View, draw the Plan



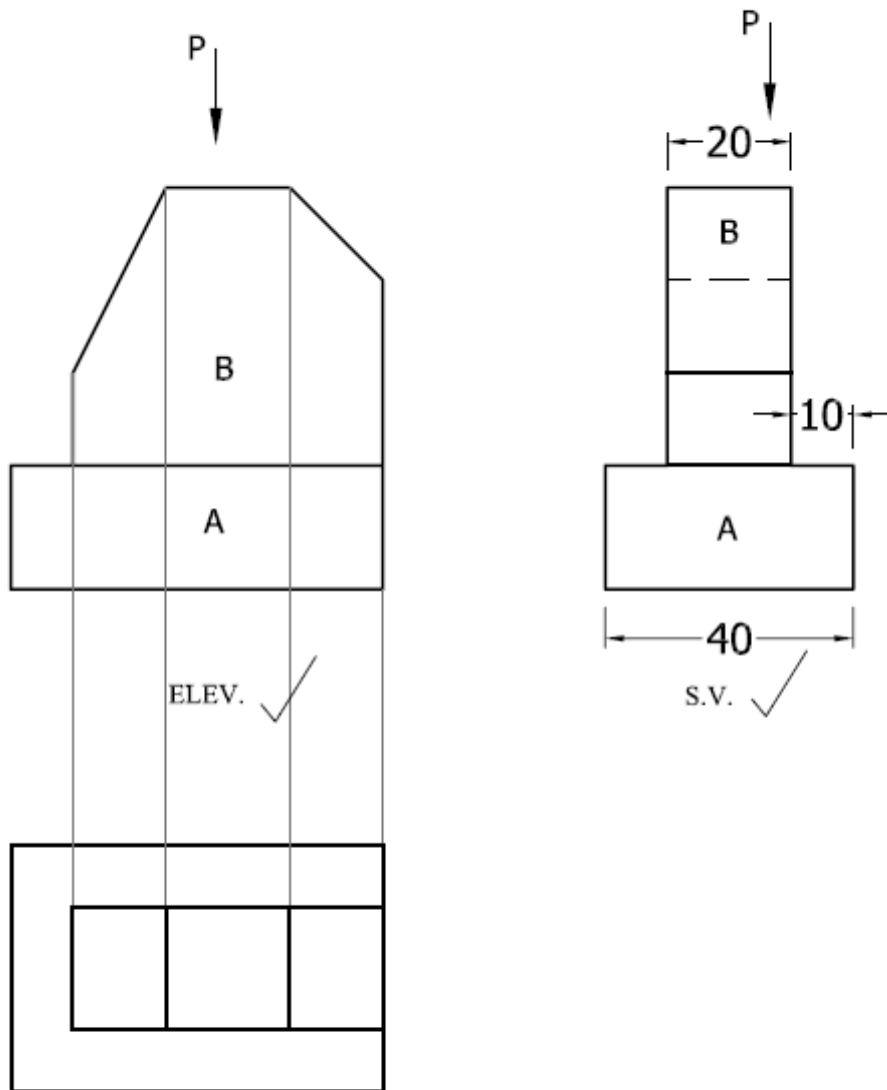
For the given Elevation and Side View, draw the Plan



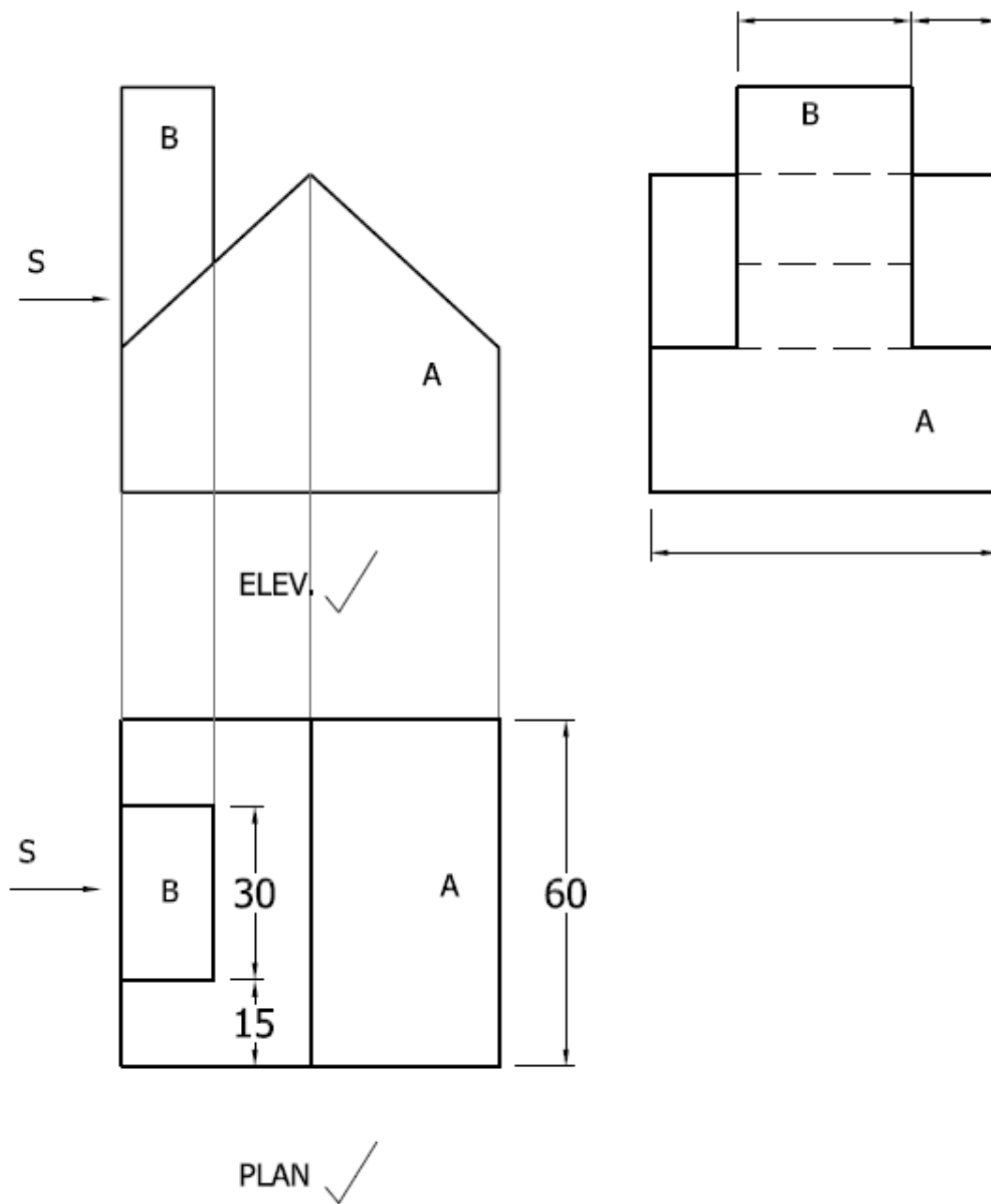
## Part 2

Simple combined objects with/without holes

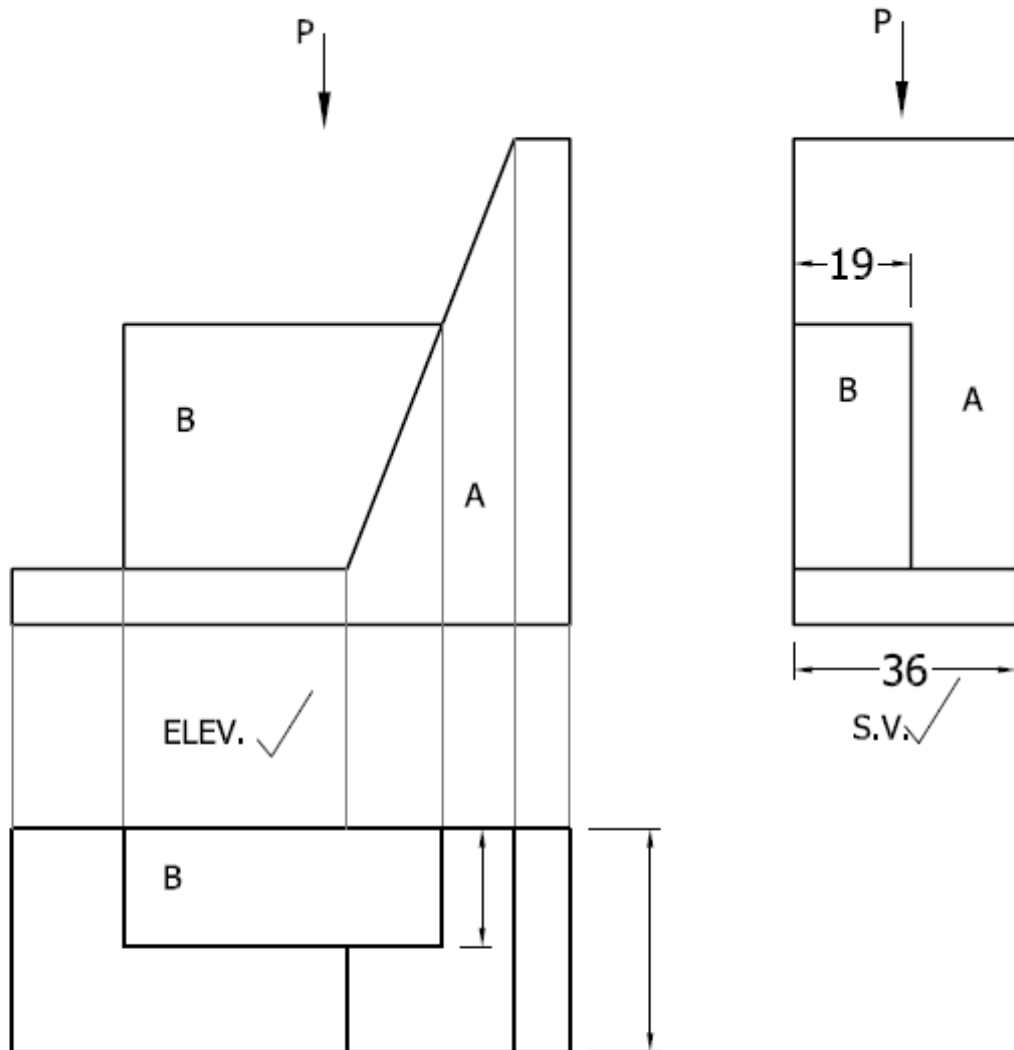
For the given Elevation and Side View, draw the Plan



For the given Elevation and PLAN , draw the Side View

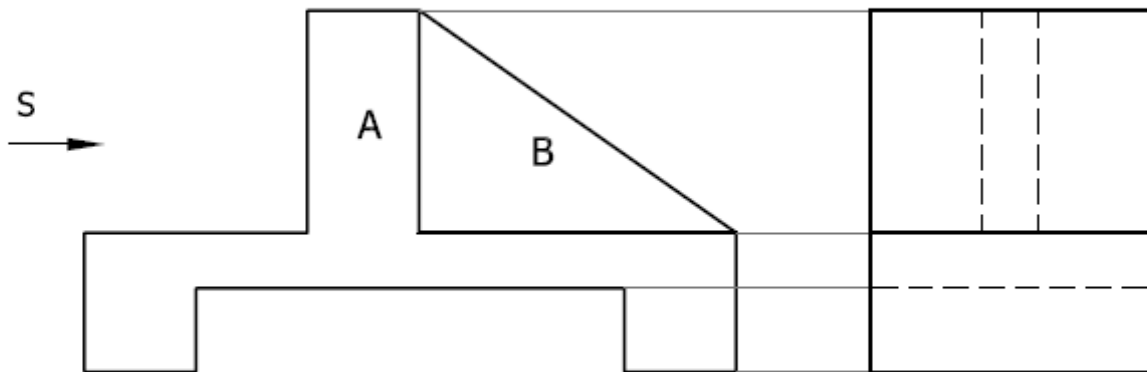


For the given Elevation and Side View, draw the Plan





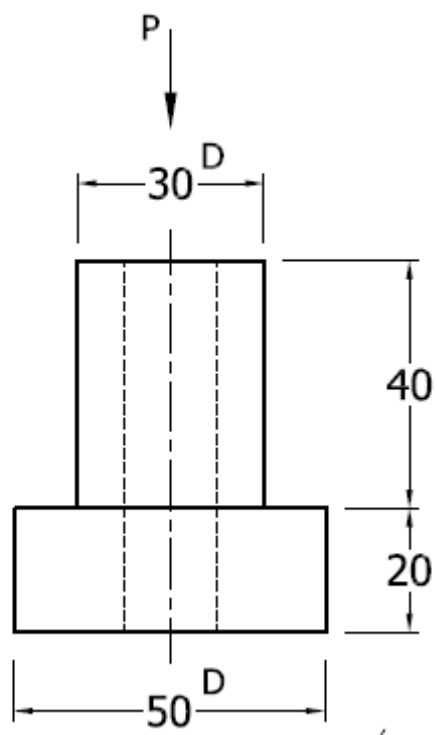
For the given Elevation and PLAN , draw the Side View



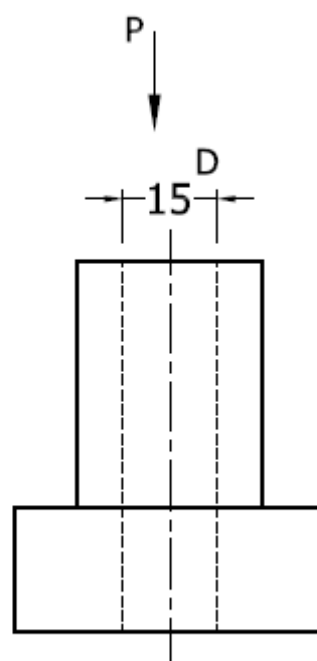
ELEV. ✓



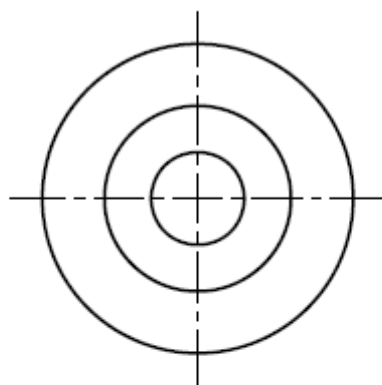
PLAN ✓



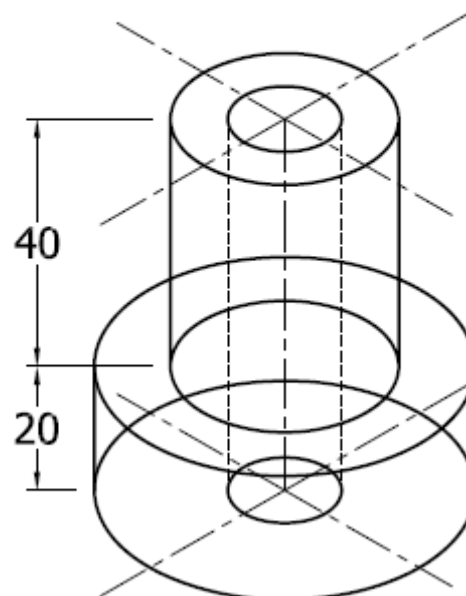
ELEVATION ✓



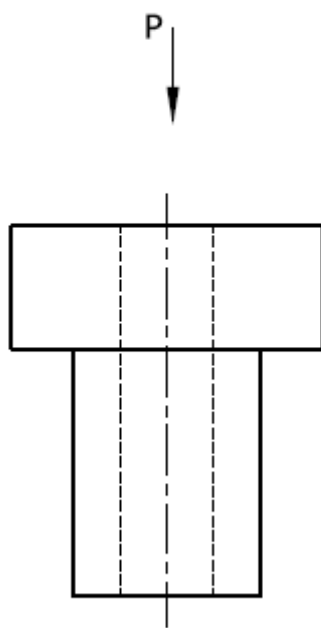
SIDE VIEW ✓



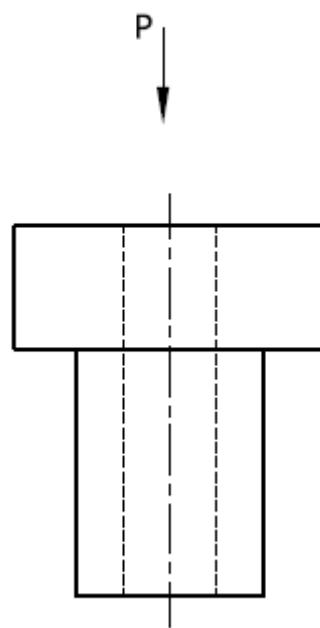
PLAN



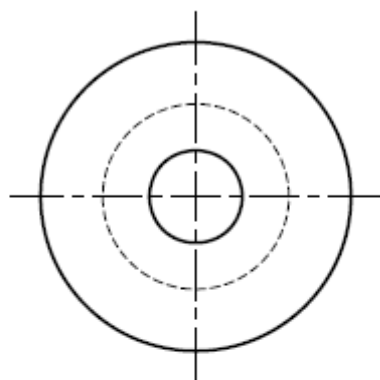
For the given Elevation and Side View, draw the Plan



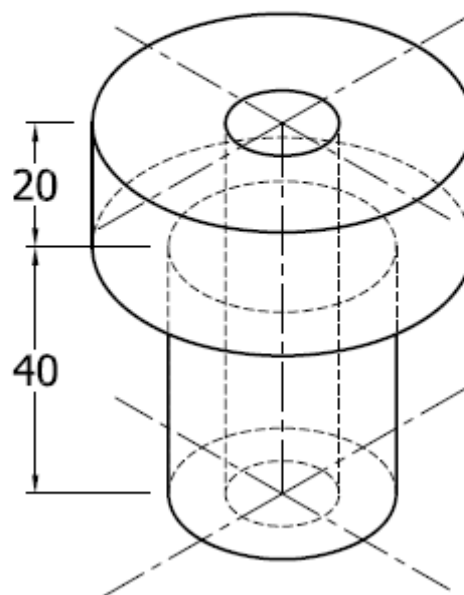
ELEVATION



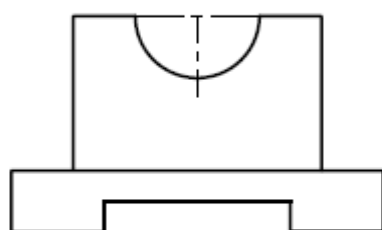
SIDE VIEW



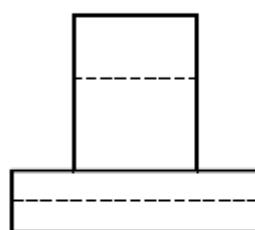
PLAN



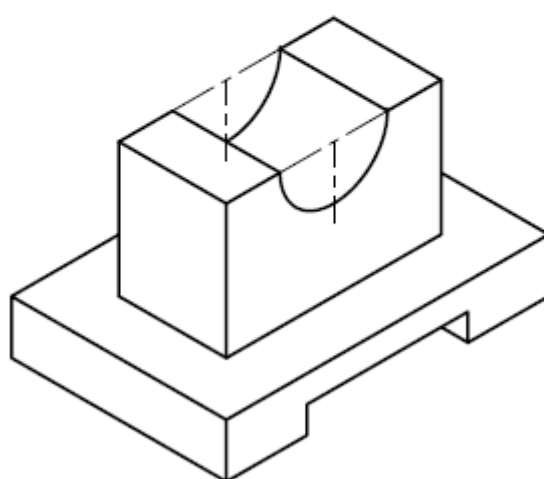
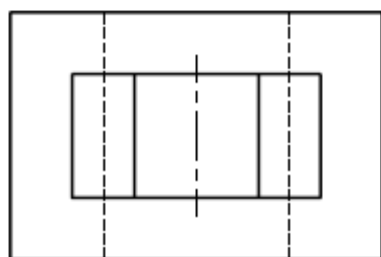
For the given Elevation and Side View, draw the Plan



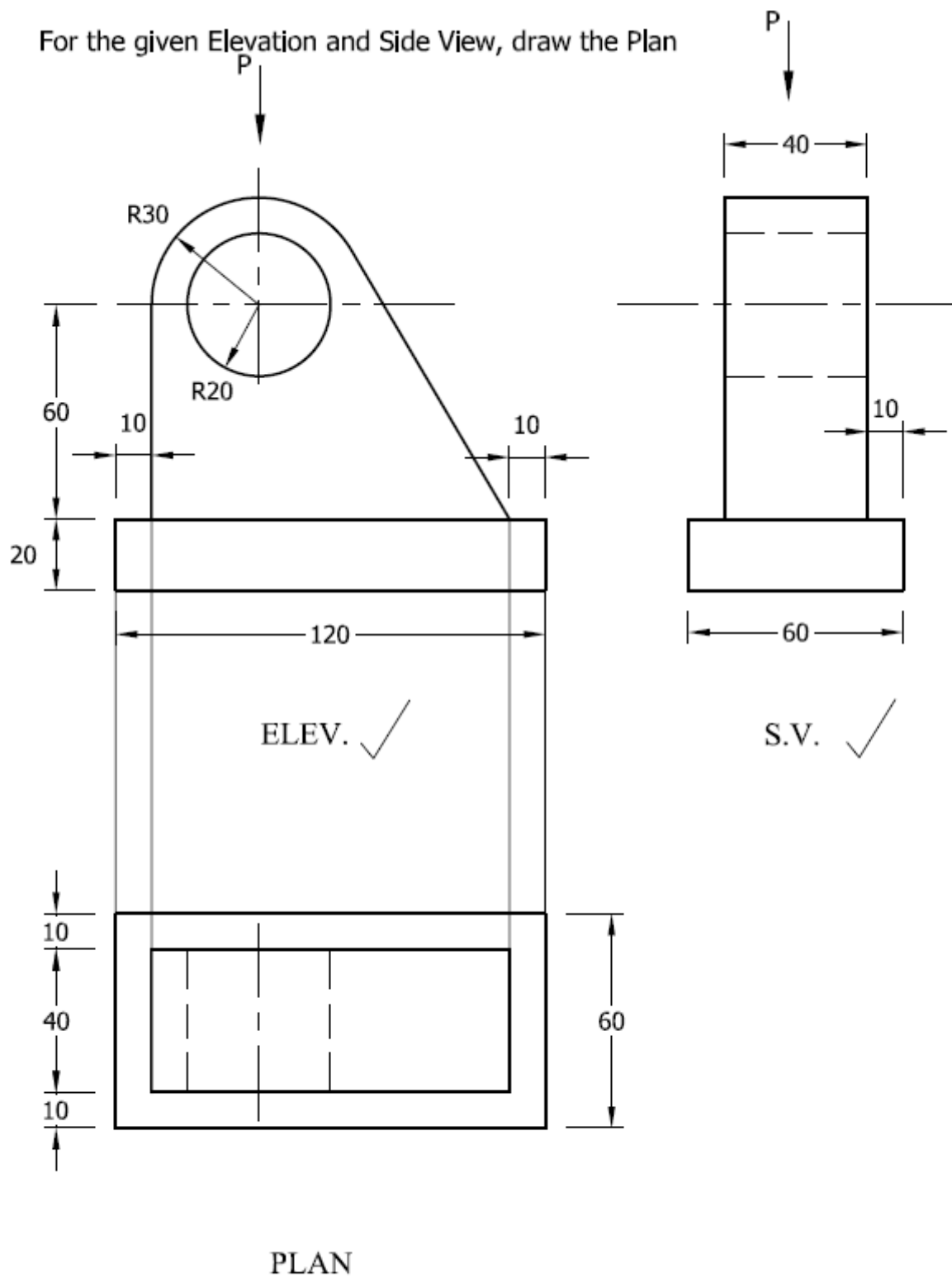
ELEVATION ✓



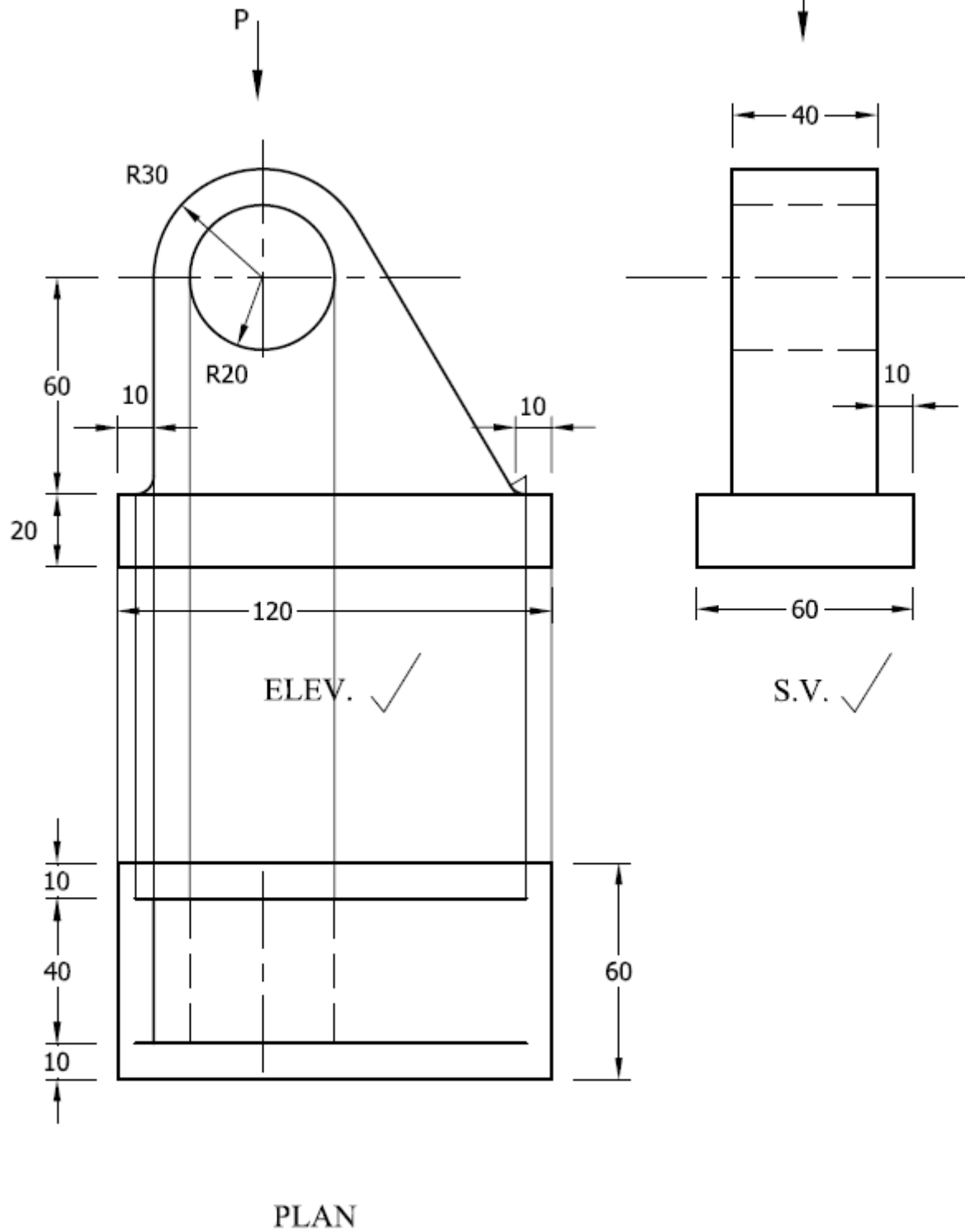
SIDE VIEW ✓



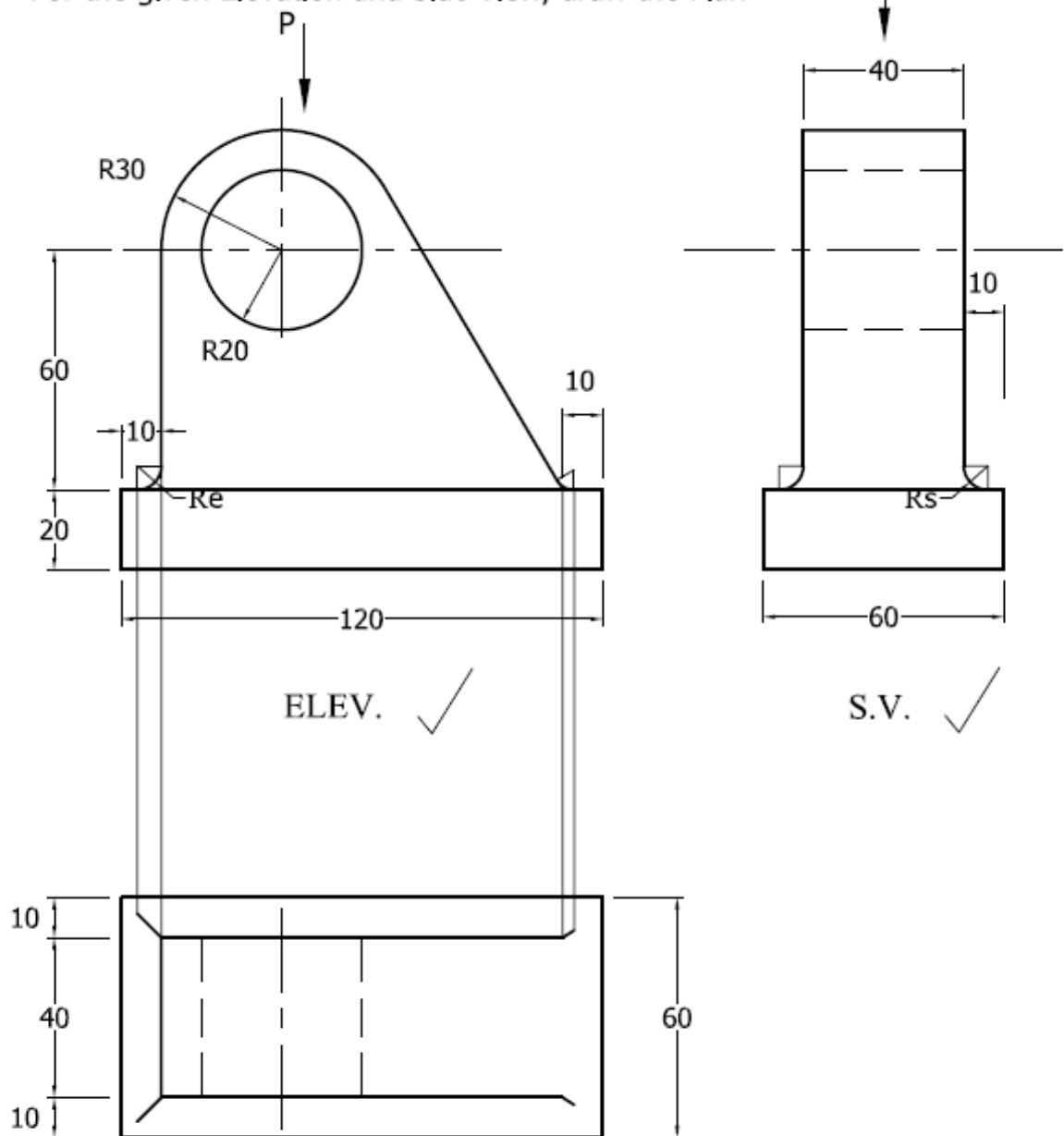
For the given Elevation and Side View, draw the Plan



For the given Elevation and Side View, draw the Plan



For the given Elevation and Side View, draw the Plan



ELEV. ✓

S.V. ✓

PLAN

$R_e = R_s = .3$

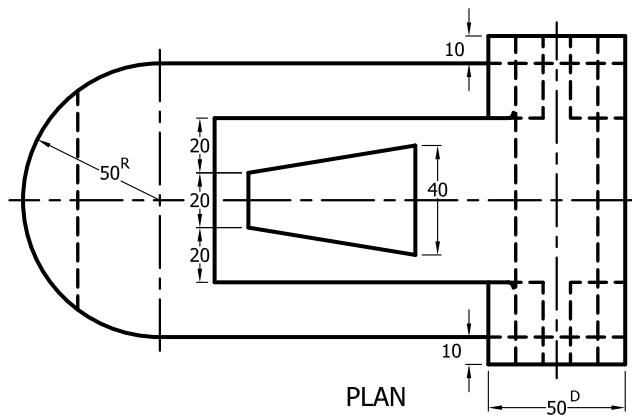
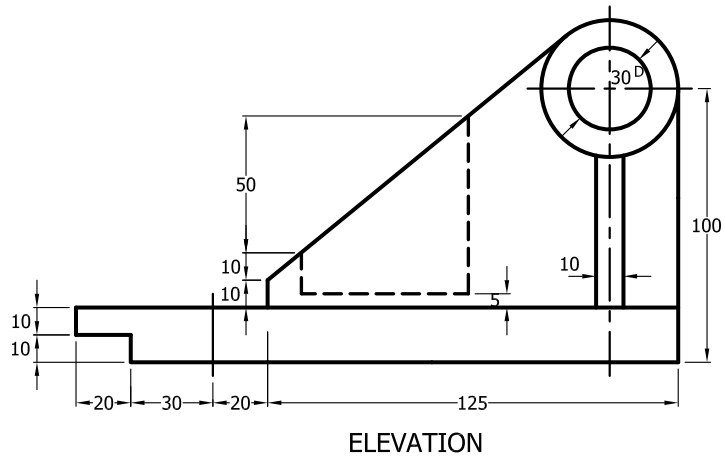
## Part 3

More complex combined objects



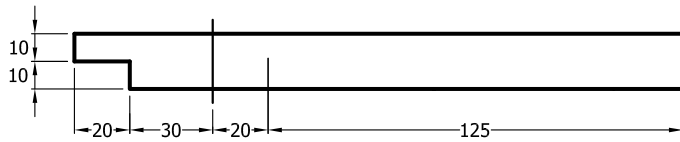
EX1

For the given machine part, draw the elevation and side view only

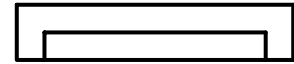


EX1

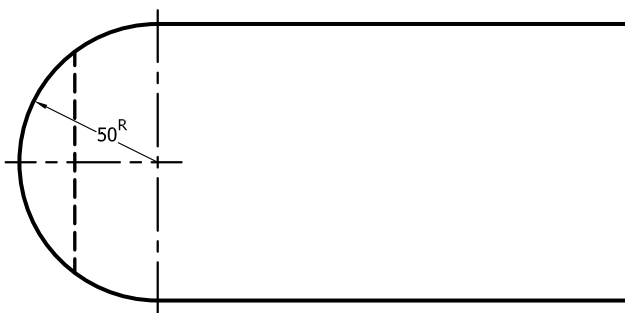
step 1



ELEVATION

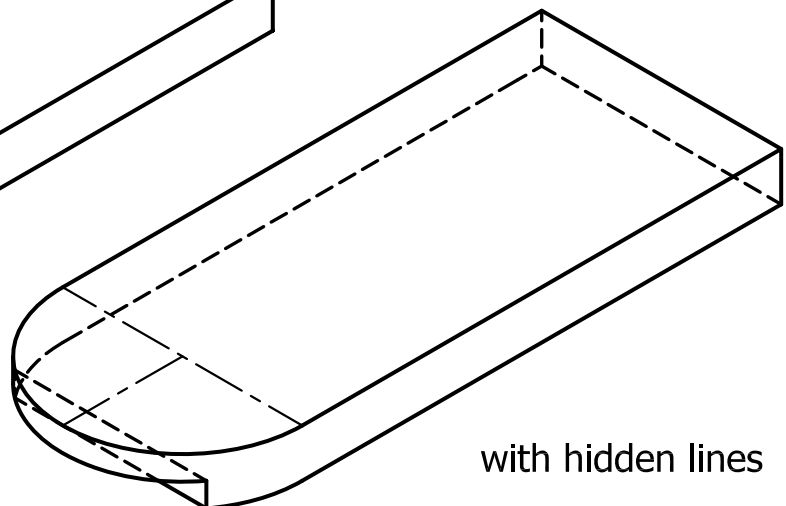
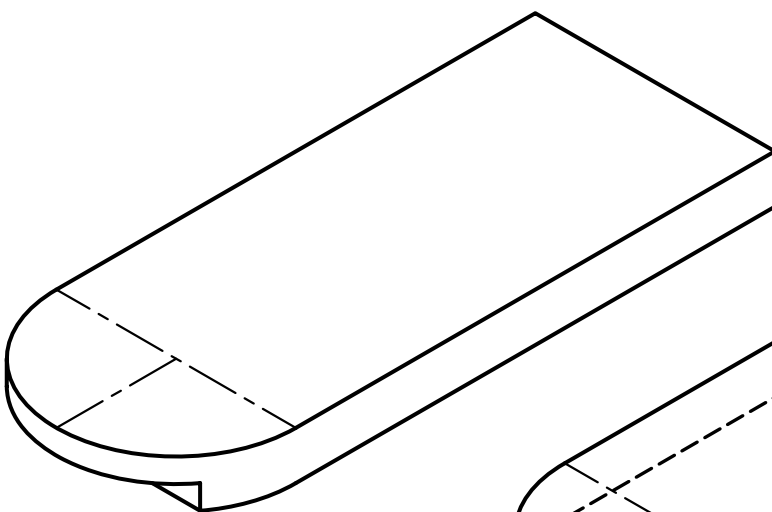


SIDE VIEW



PLAN

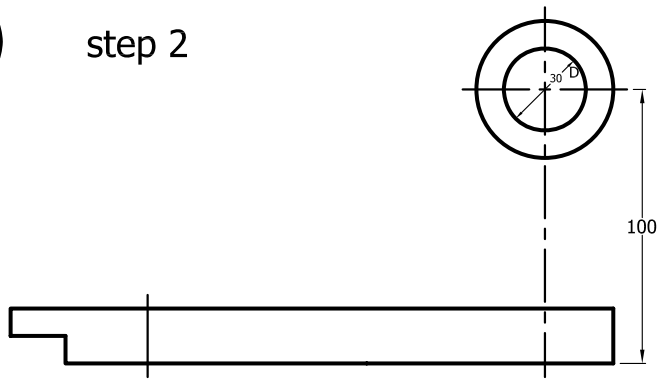
without hidden lines



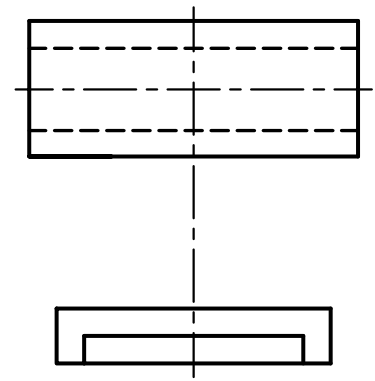
with hidden lines

EX1

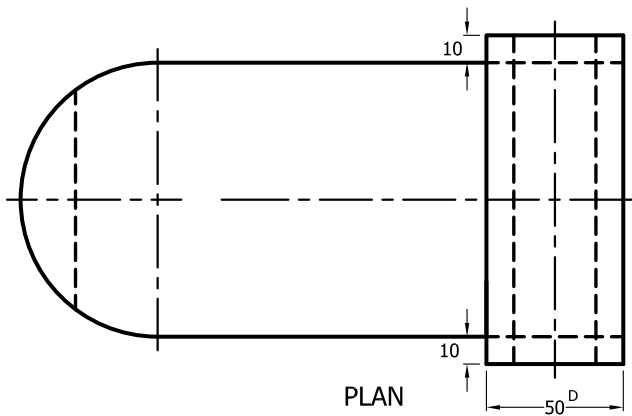
step 2



ELEVATION

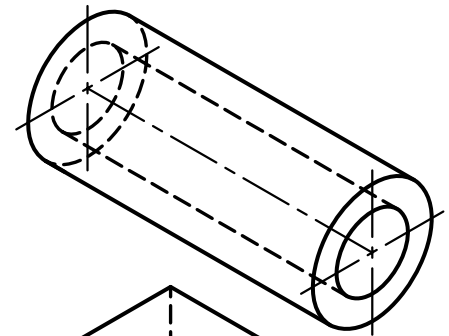
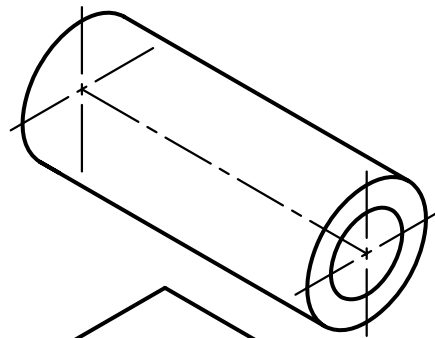


SIDE VIEW



PLAN

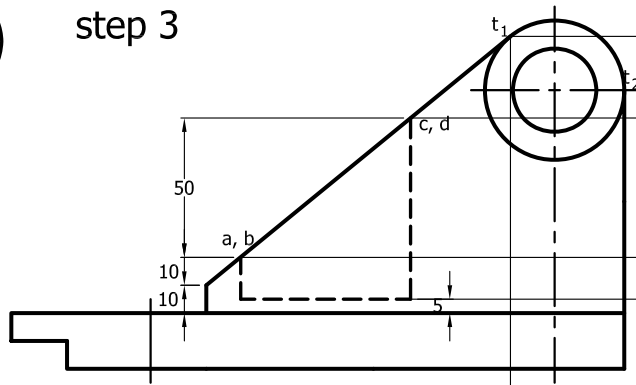
without hidden lines



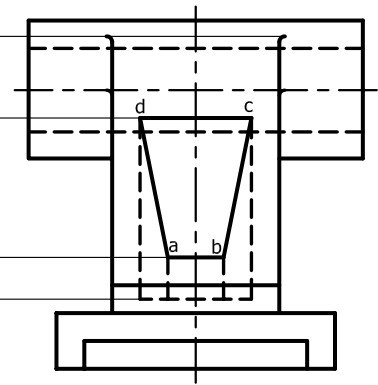
with hidden lines

EX1

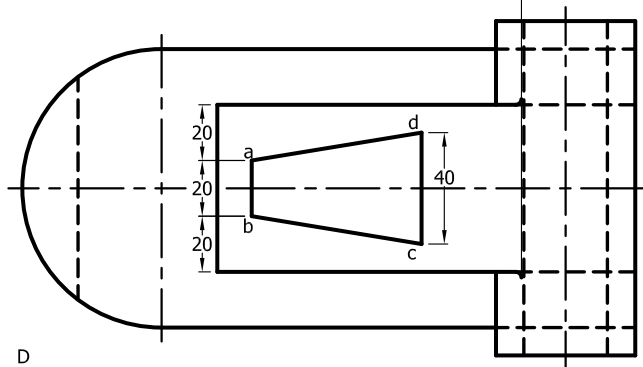
step 3



ELEVATION

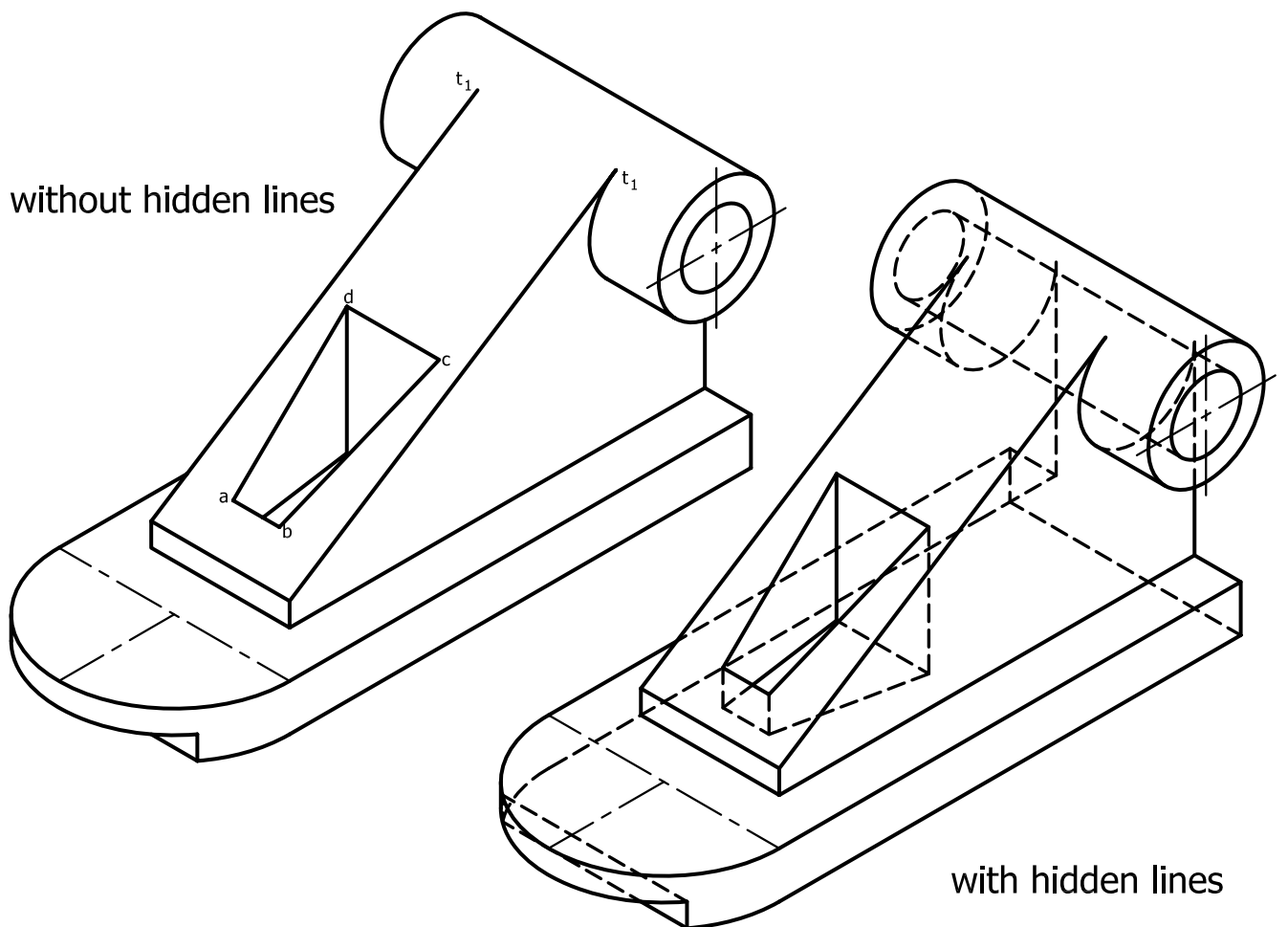


SIDE VIEW



D

PLAN

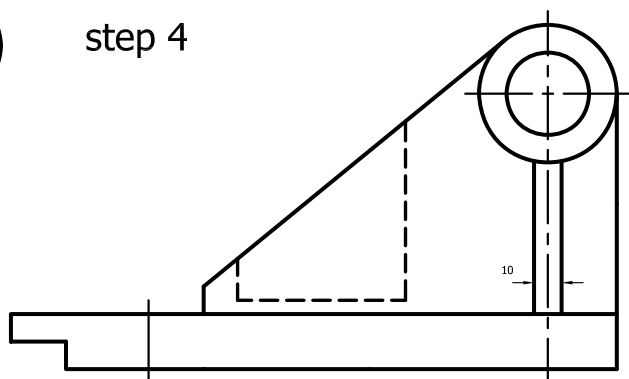


without hidden lines

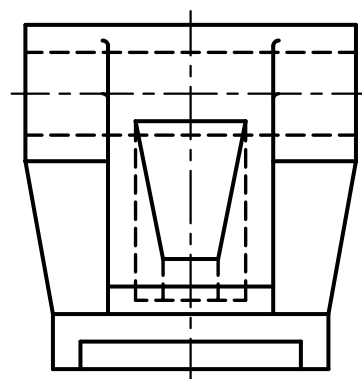
with hidden lines

EX1

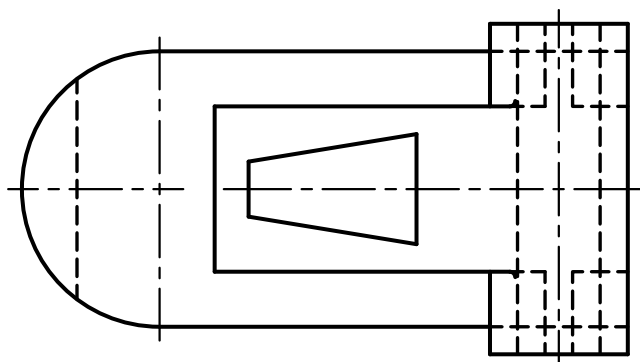
step 4



ELEVATION

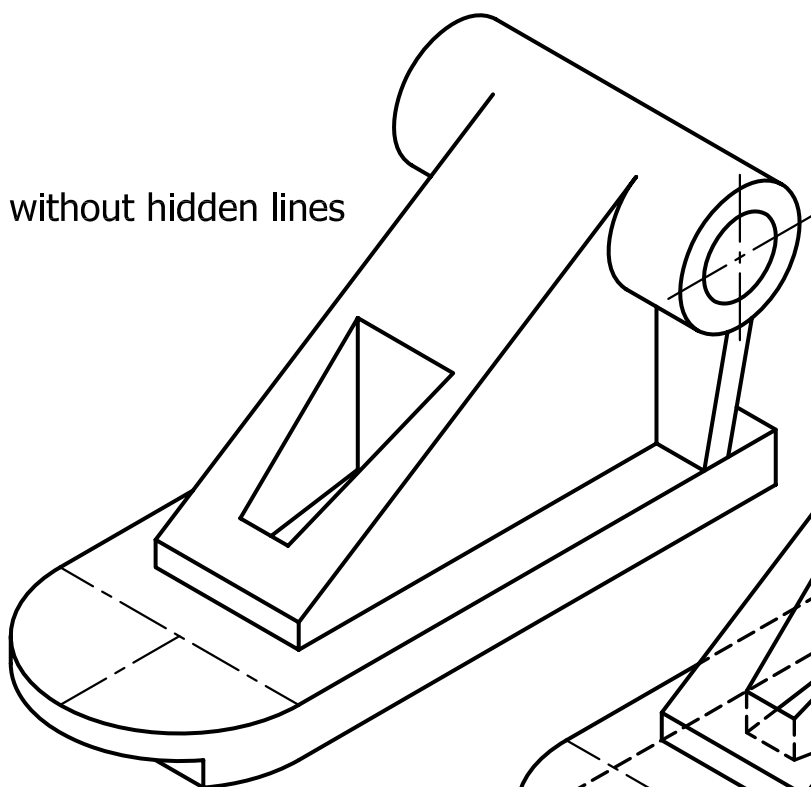


SIDE VIEW

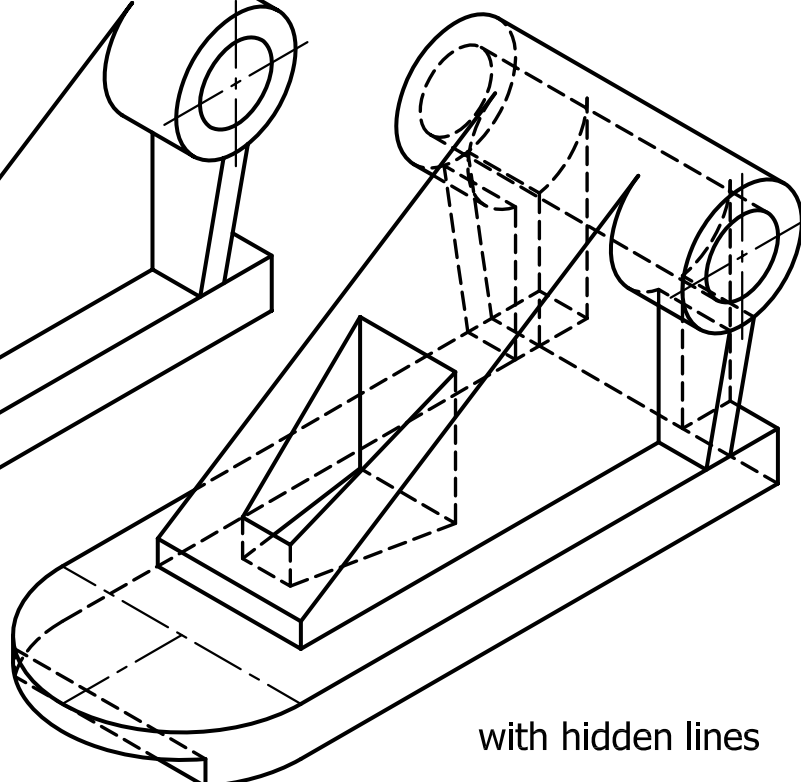


PLAN

without hidden lines

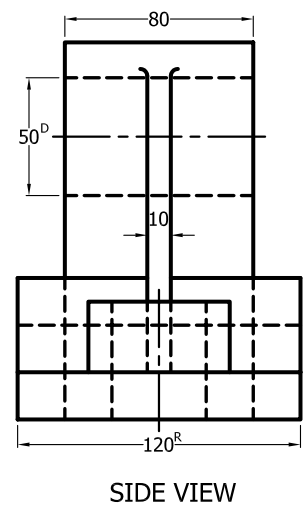
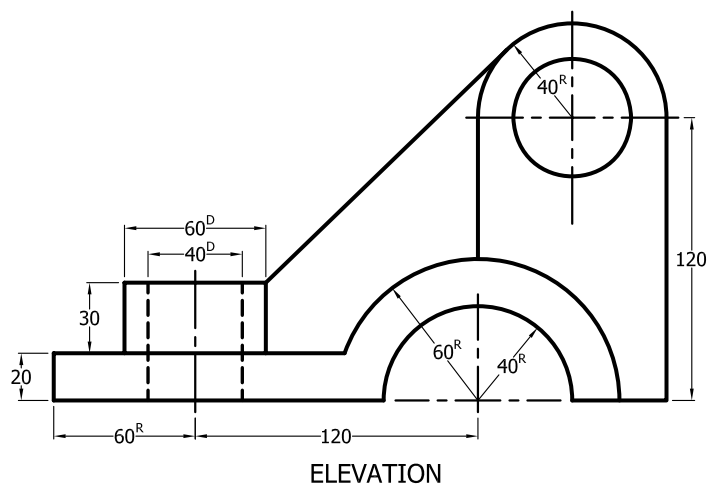


with hidden lines



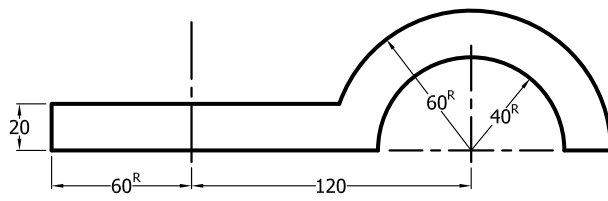
EX2

For the given machine part, draw the elevation and side view only

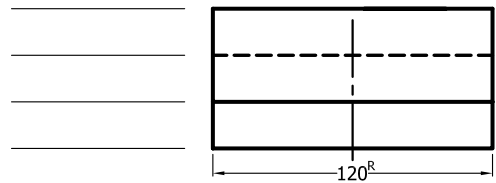


EX2

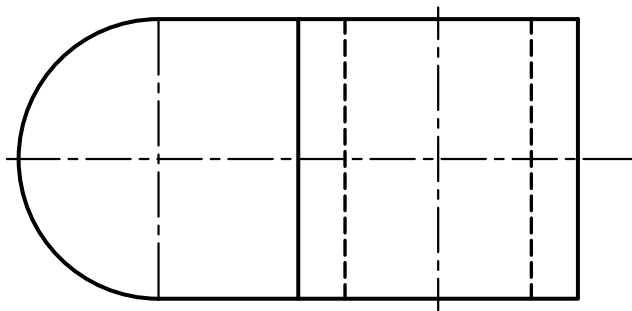
step 1



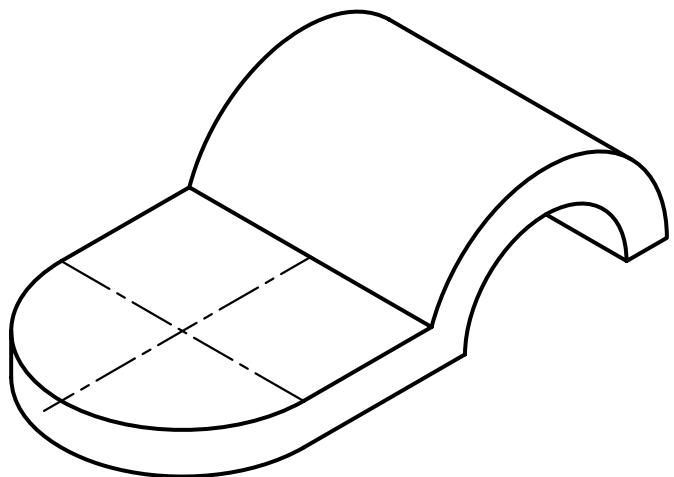
ELEVATION



SIDE VIEW

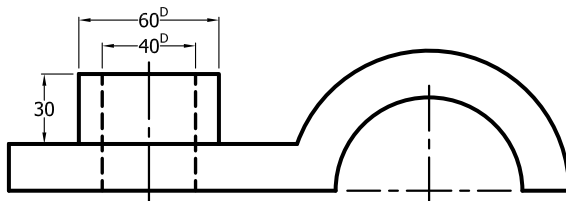


PLAN

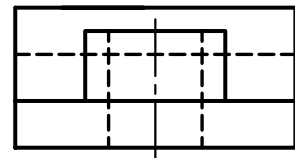


EX2

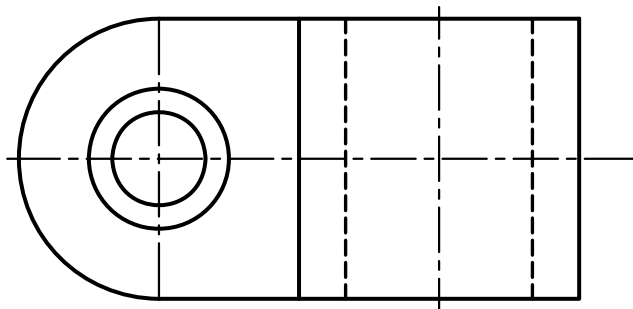
step 2



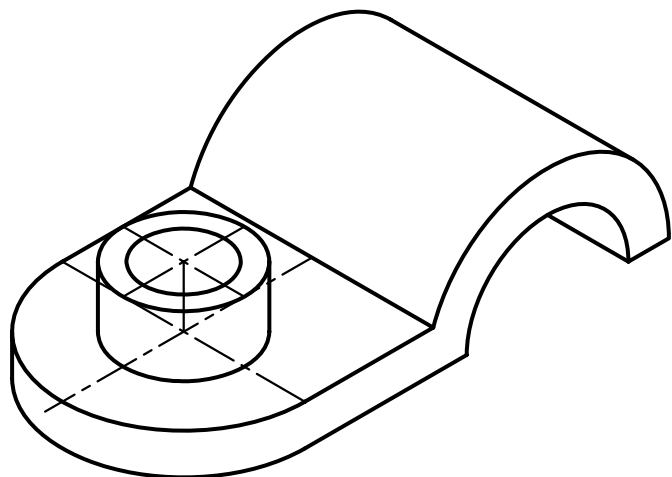
ELEVATION



SIDE VIEW



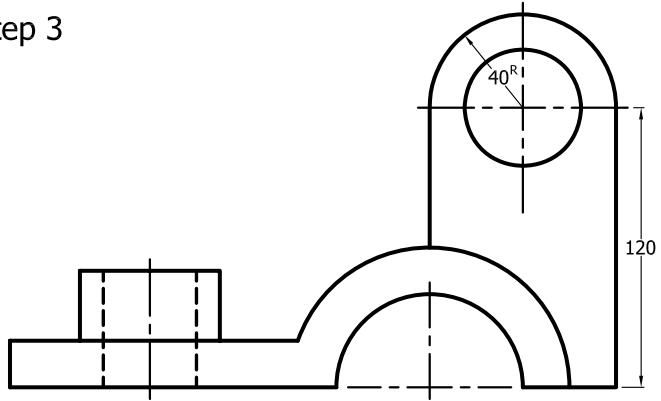
PLAN



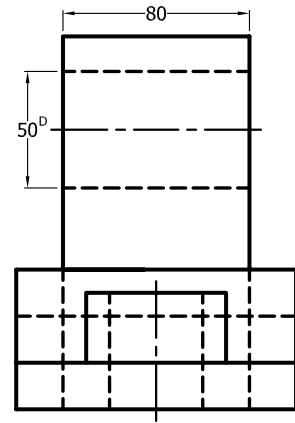


EX2

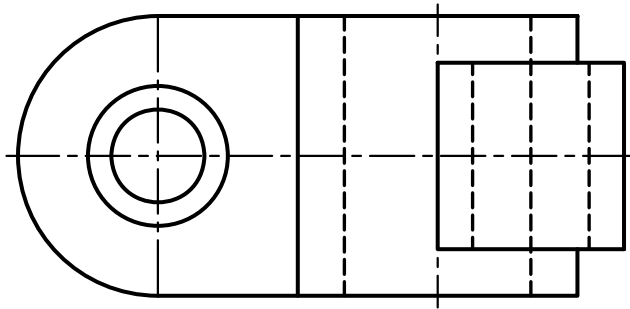
step 3



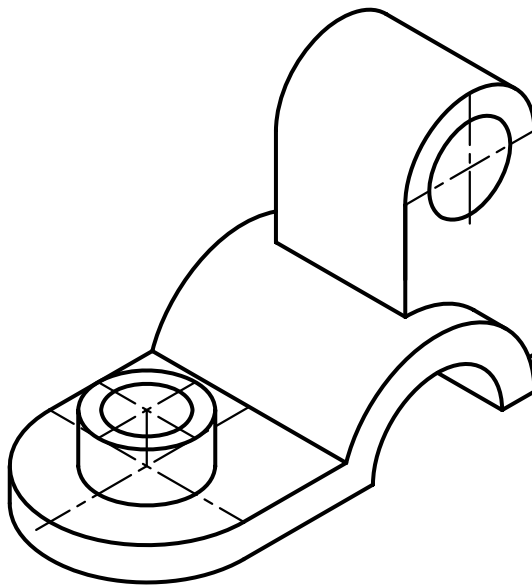
ELEVATION



SIDE VIEW

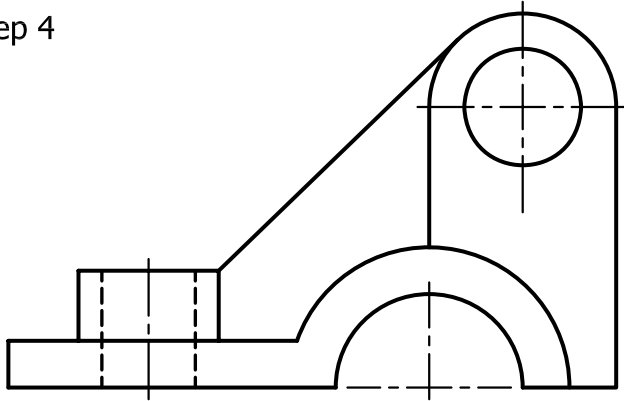


PLAN

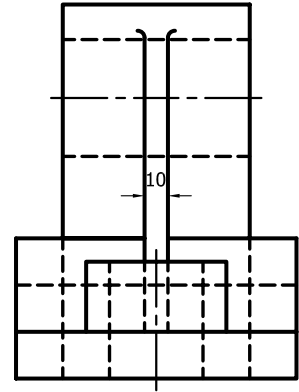


EX2

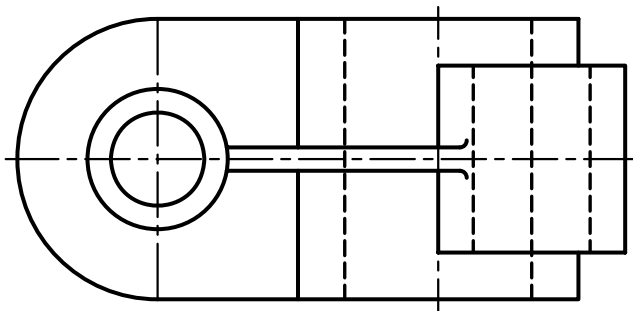
step 4



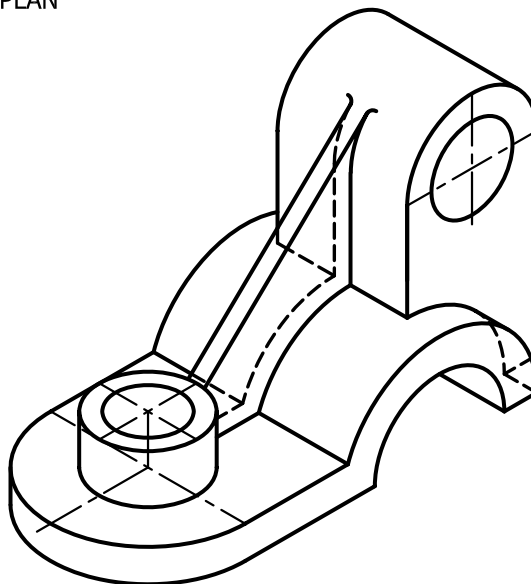
ELEVATION



SIDE VIEW

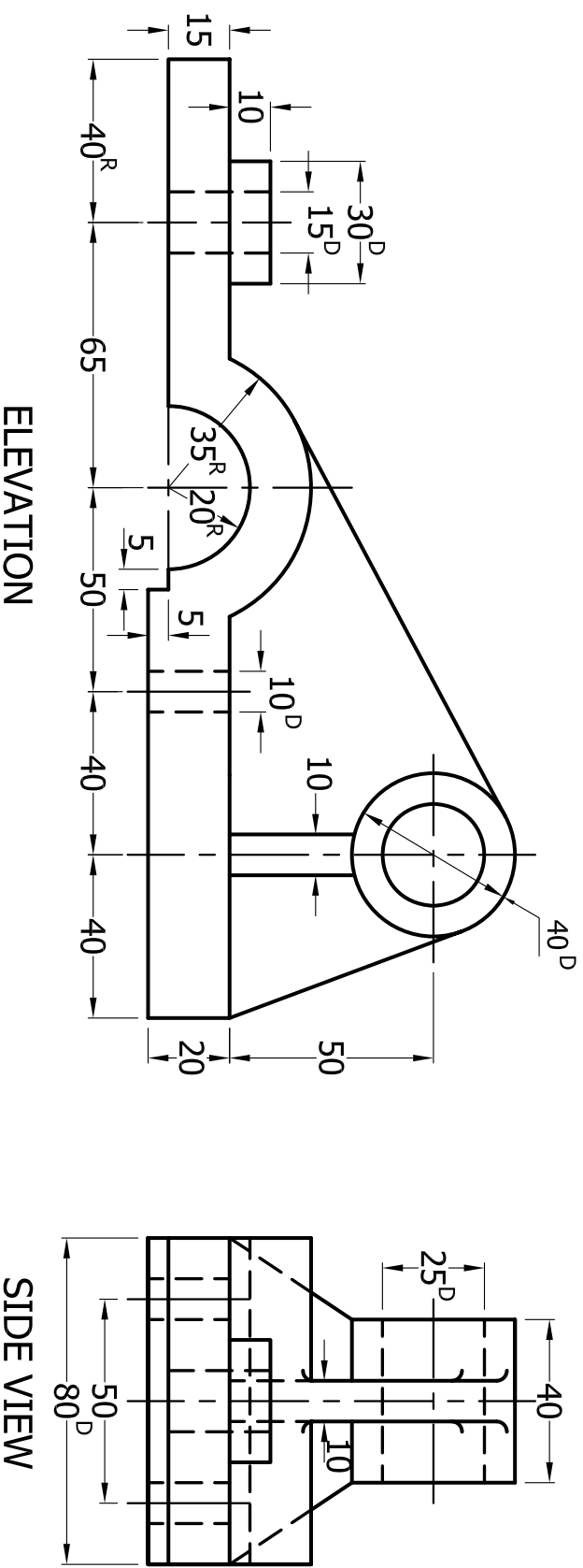


PLAN



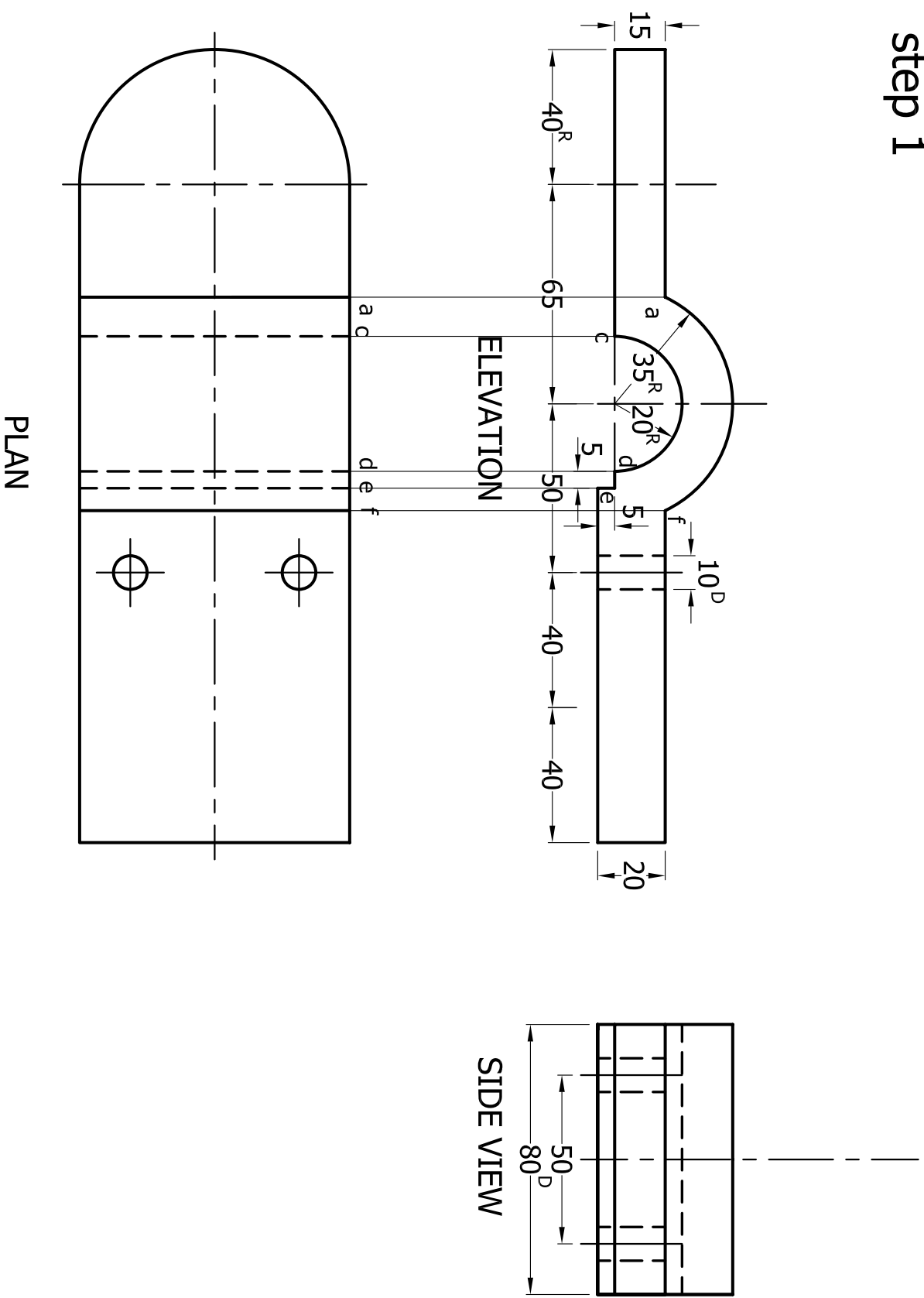
EX4

For the given machine part, draw the elevation and side view only

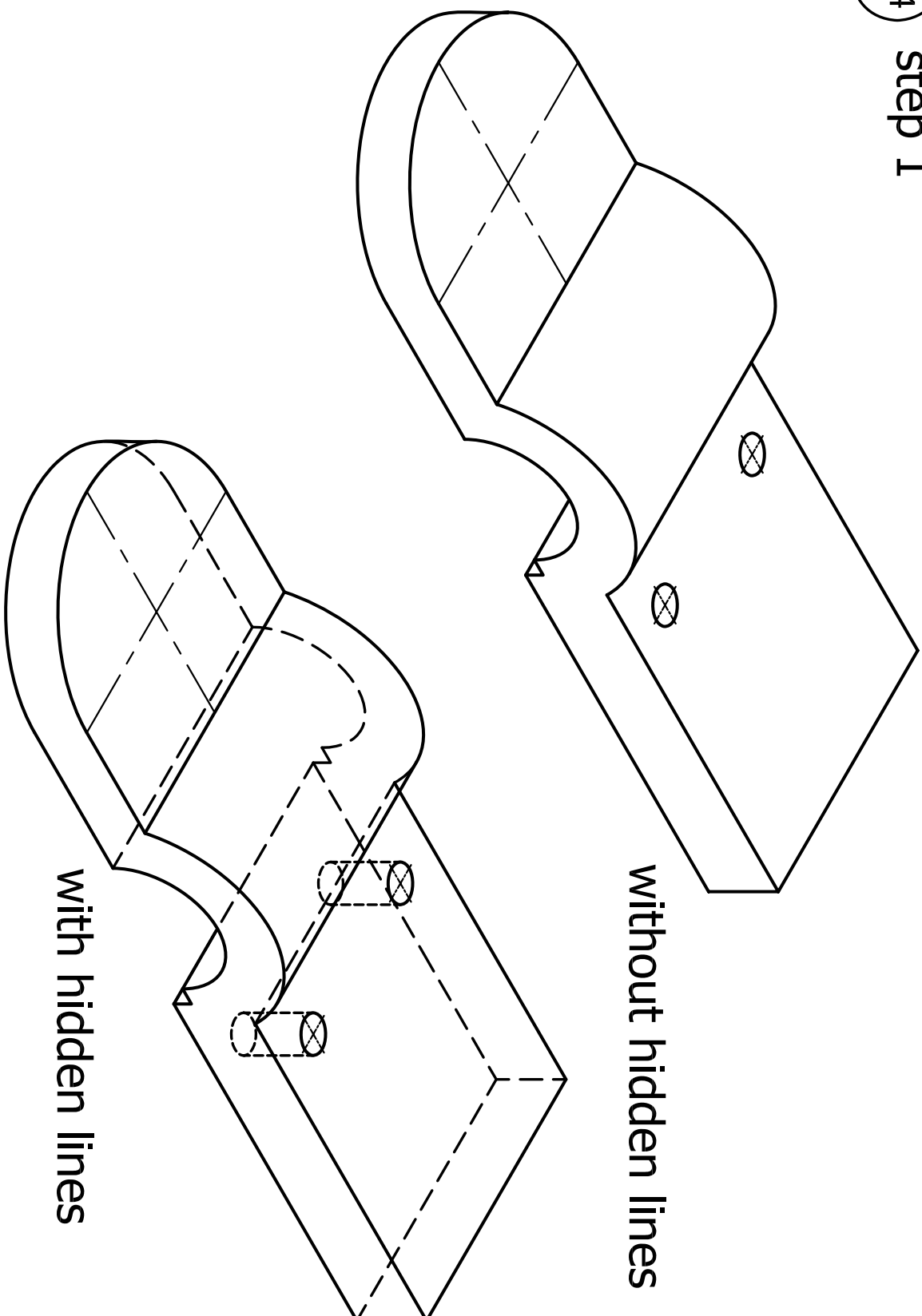


EX4

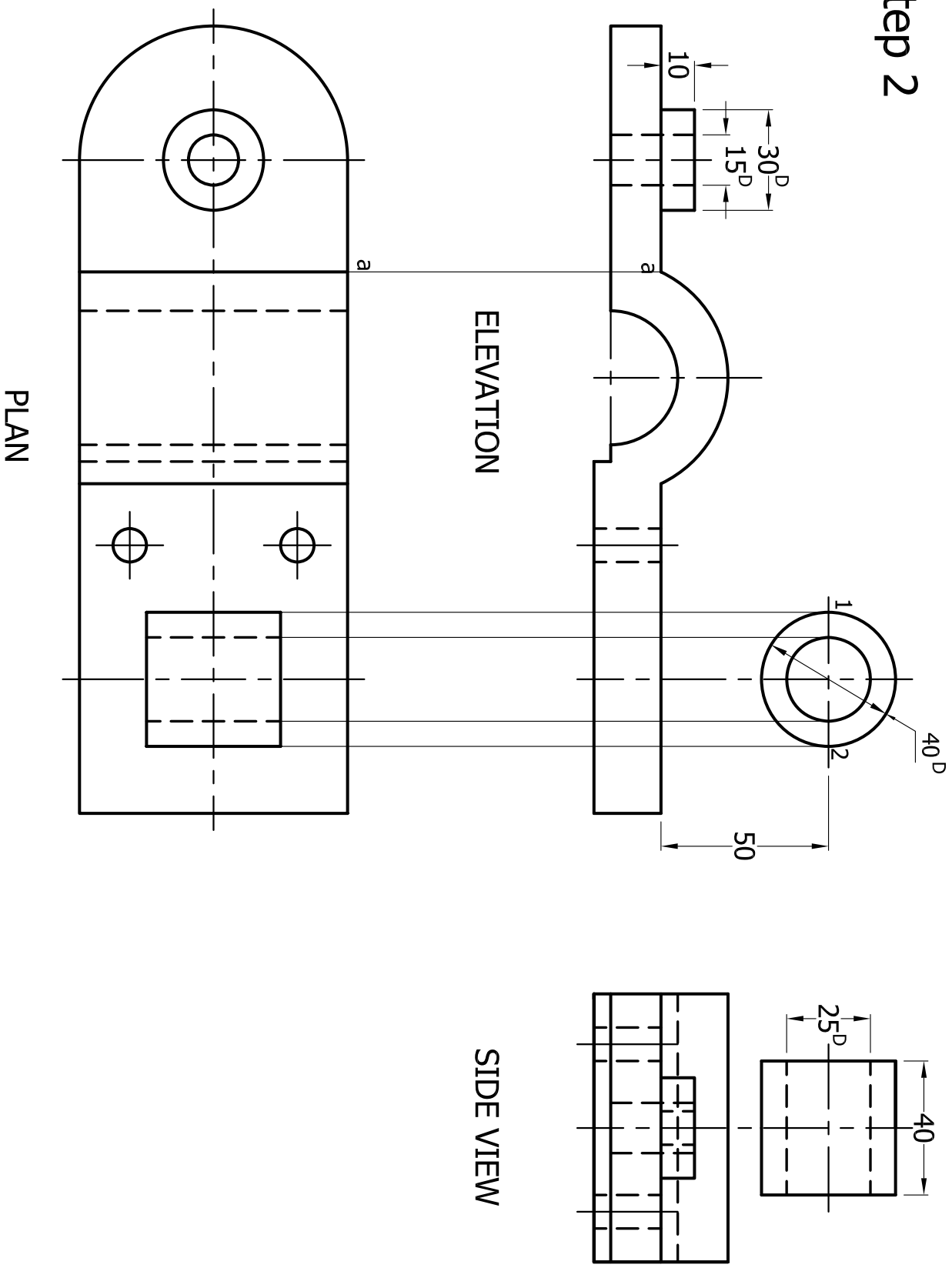
## step 1



EX4 step 1



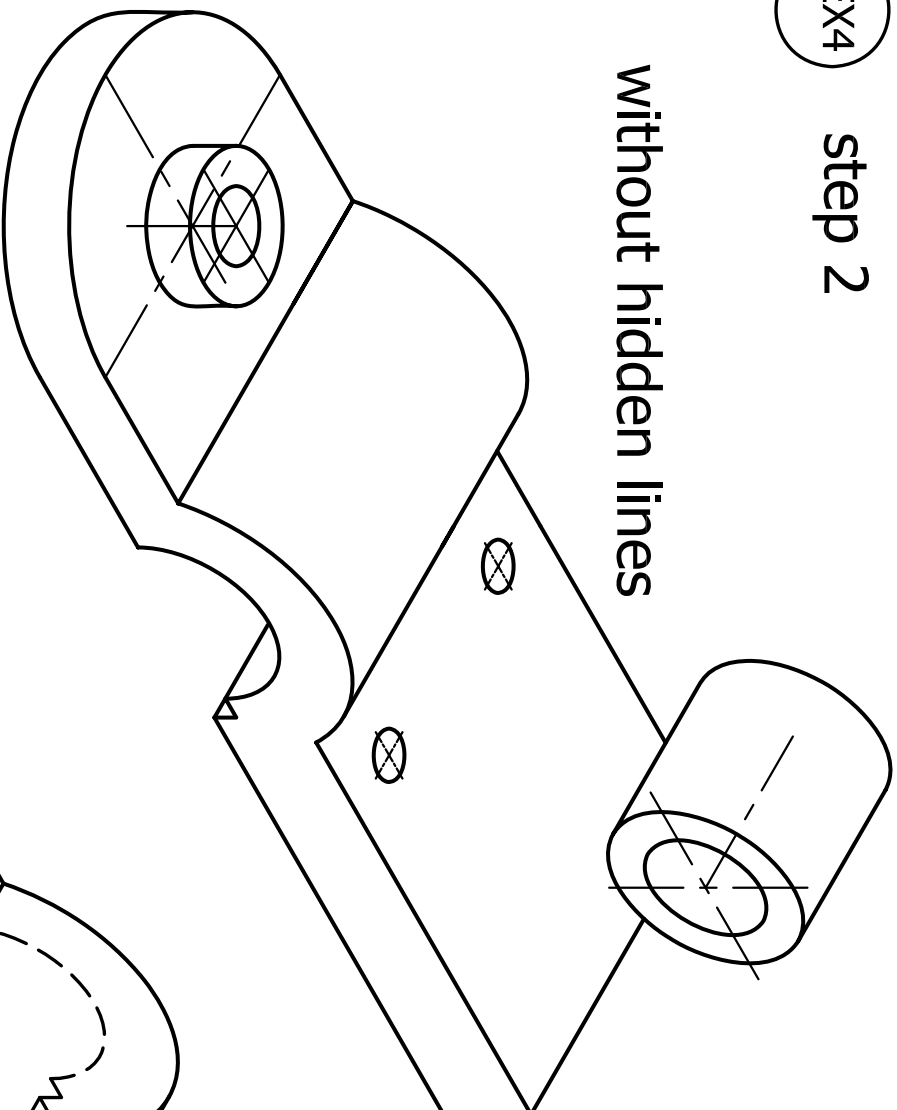
EX4 step 2



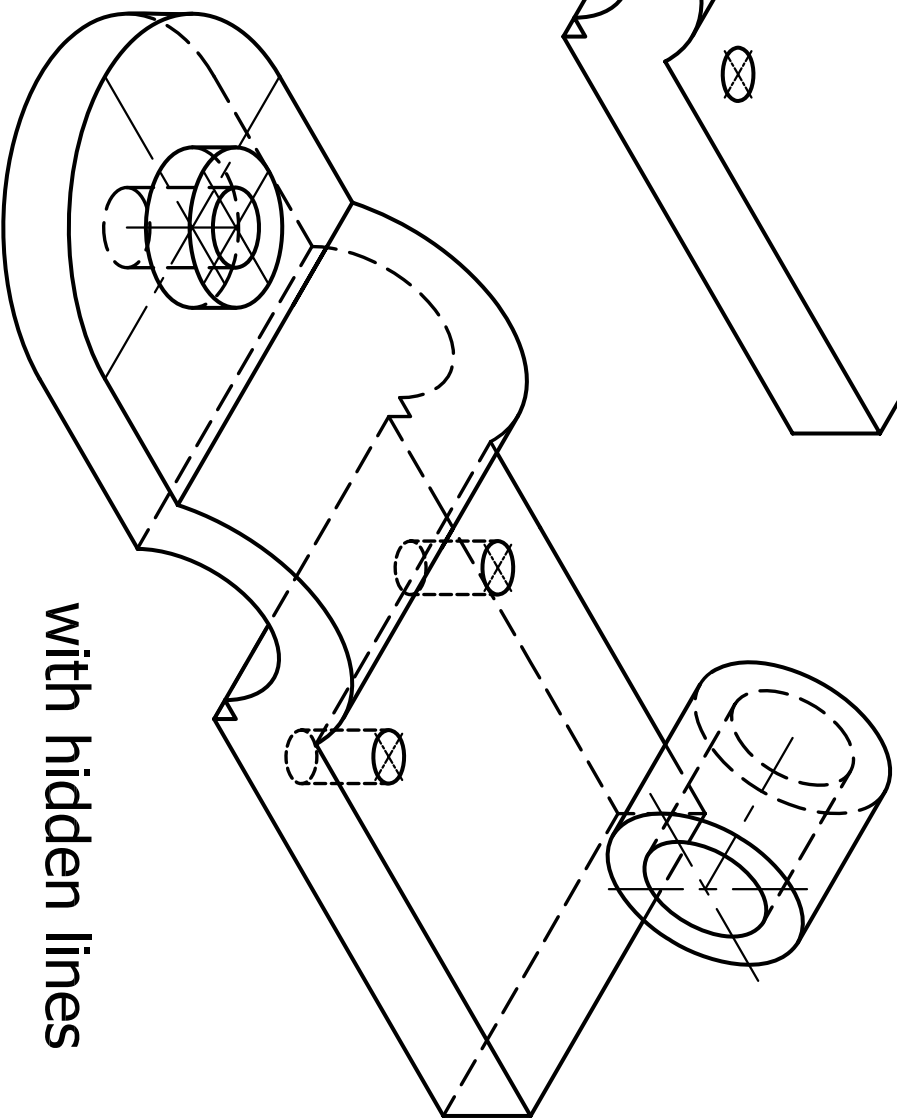
EX4

step 2

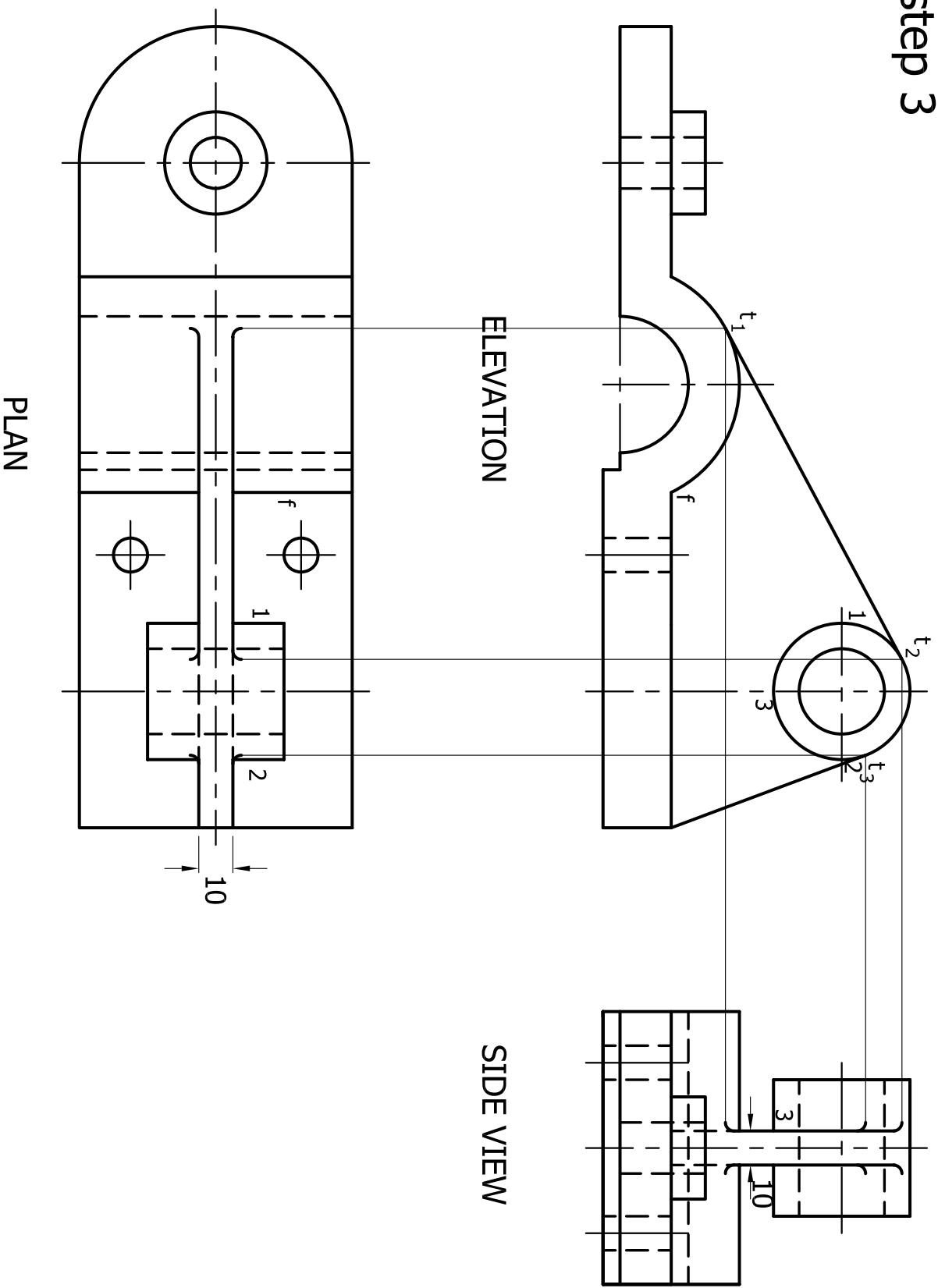
without hidden lines



with hidden lines



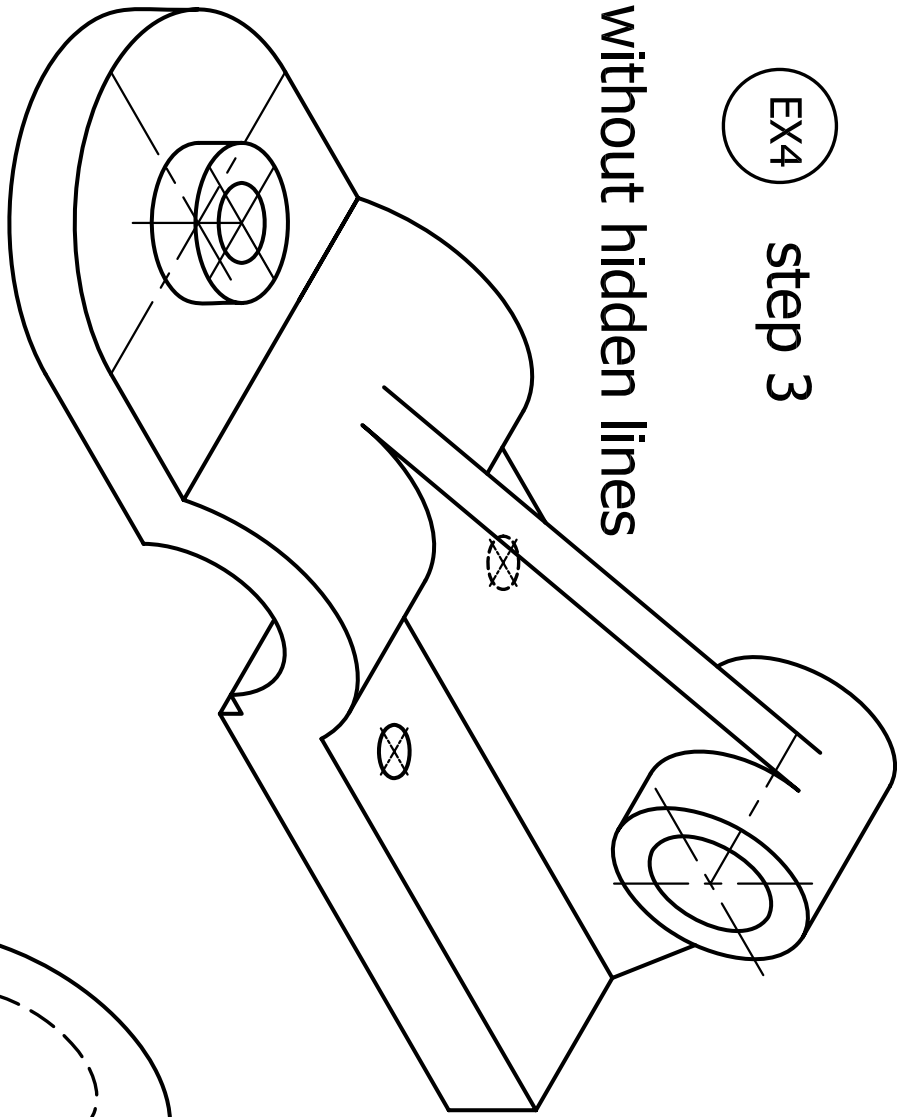
EX4 step 3



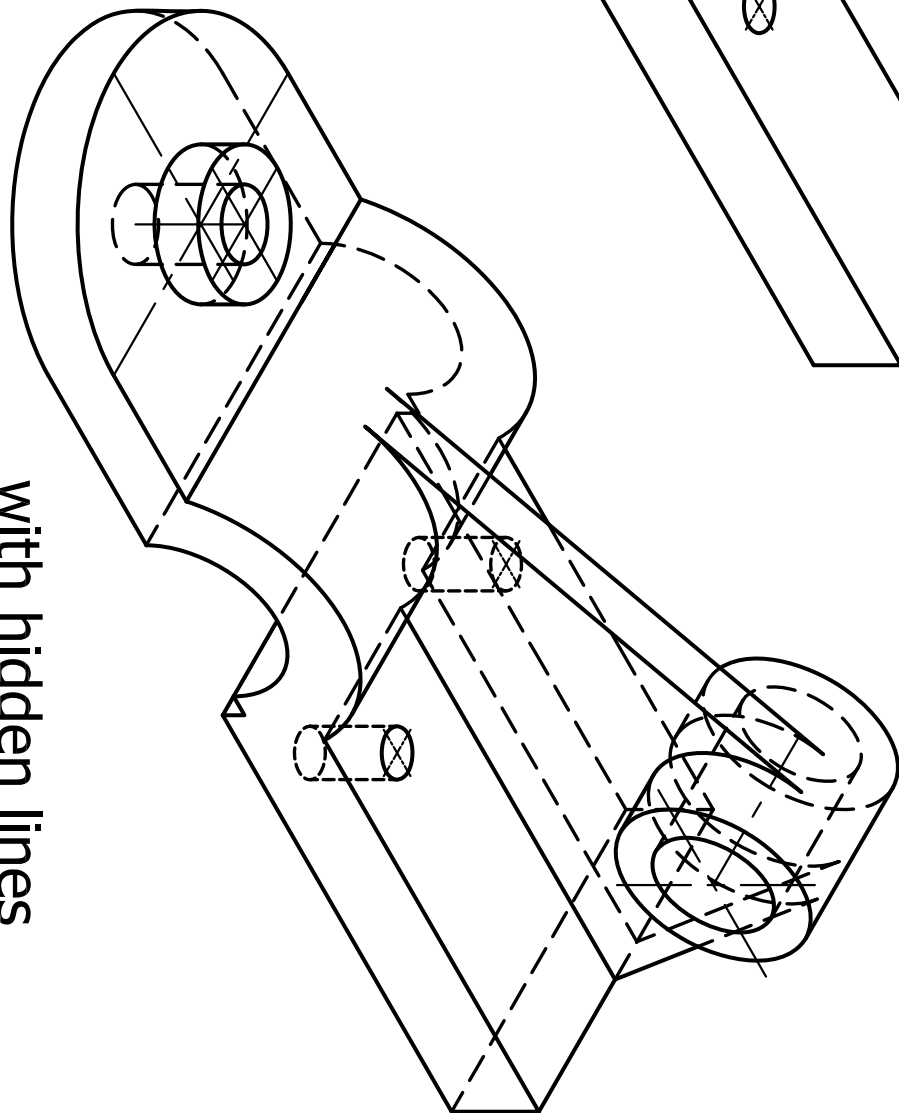


EX4 step 3

without hidden lines

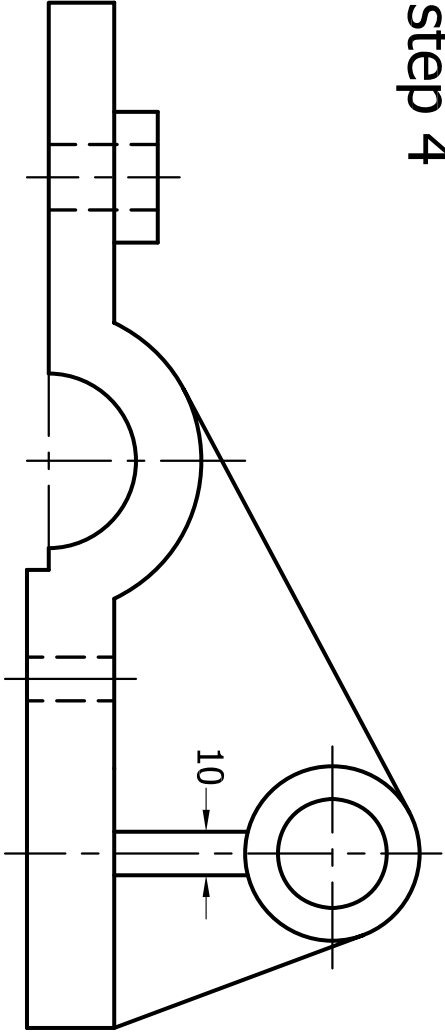


with hidden lines

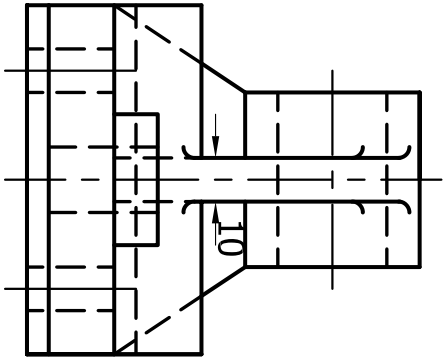


EX4

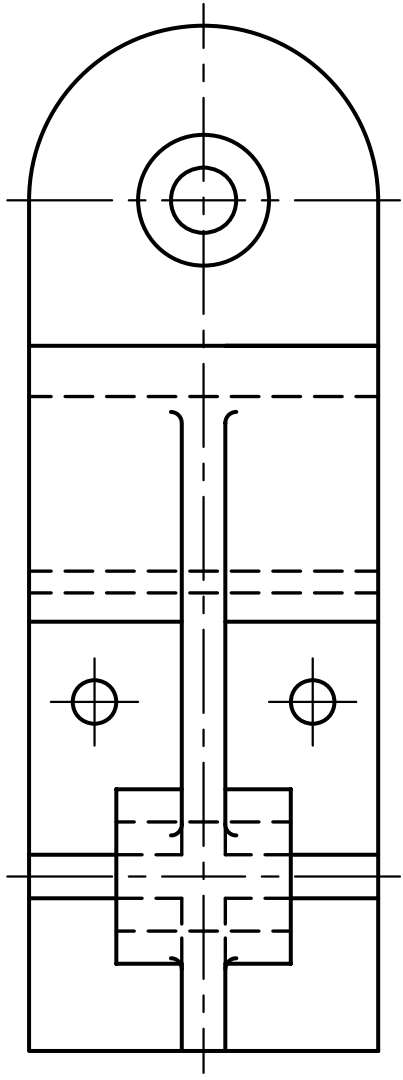
step 4



ELEVATION



SIDE VIEW

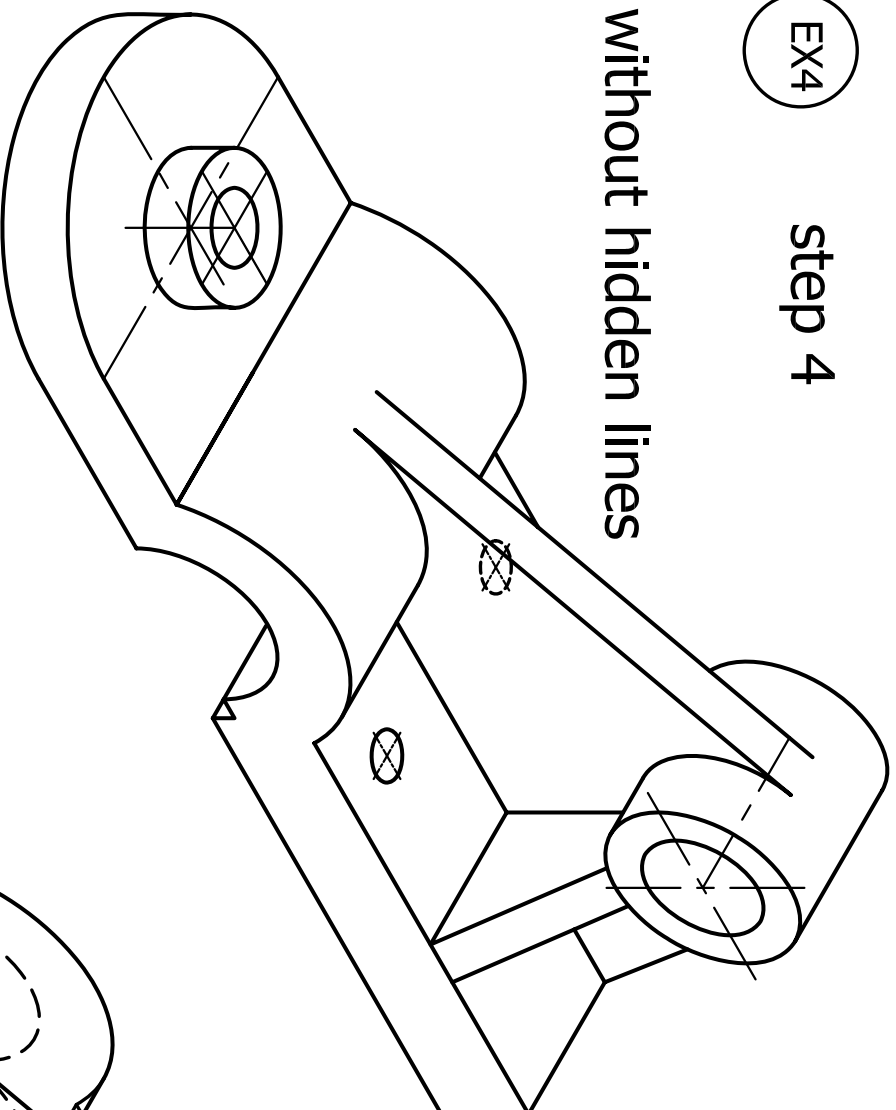


PLAN

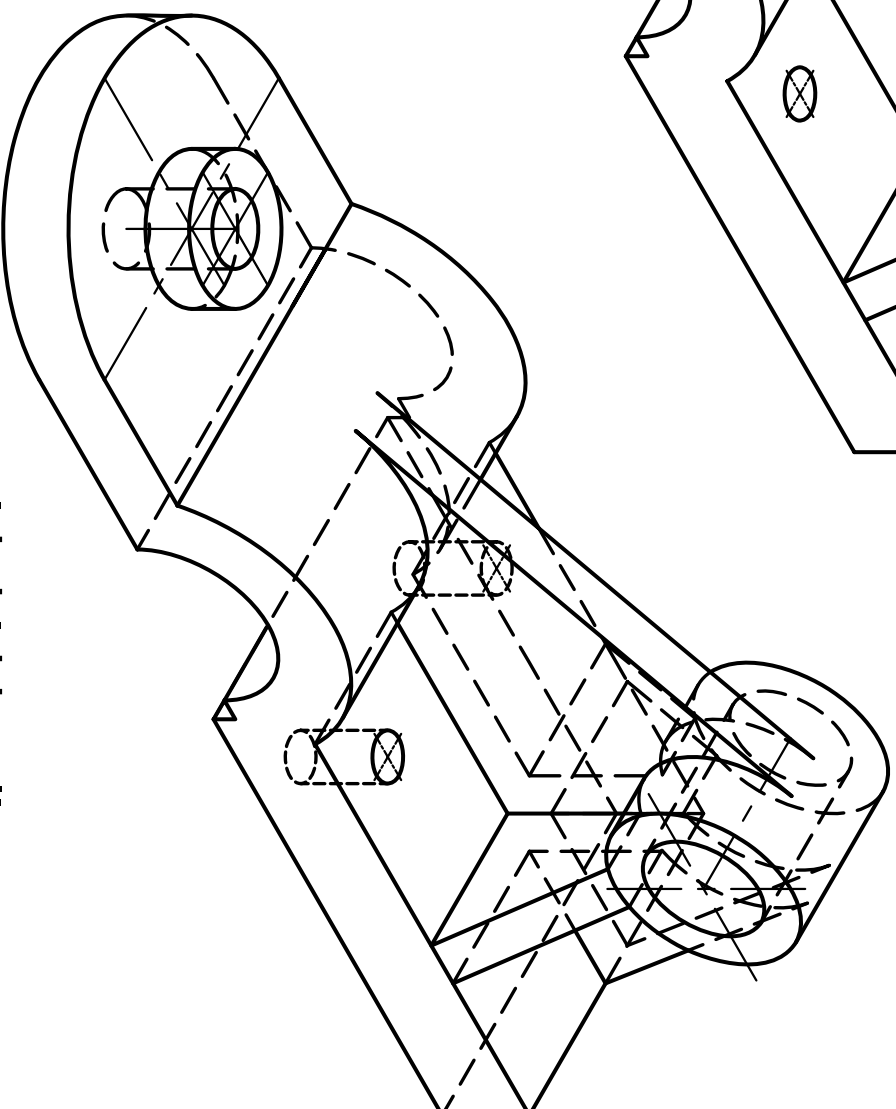
EX4

step 4

without hidden lines



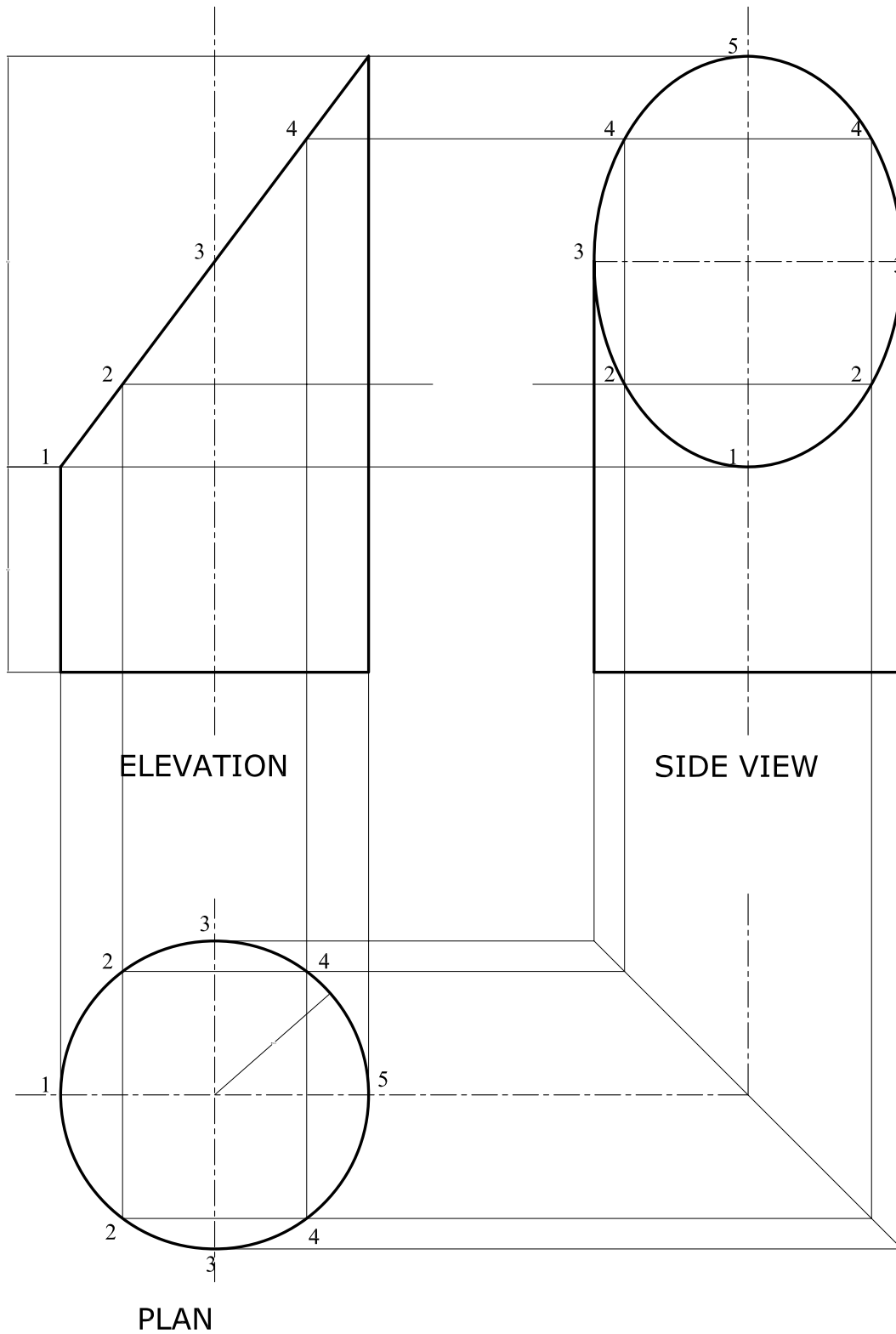
with hidden lines

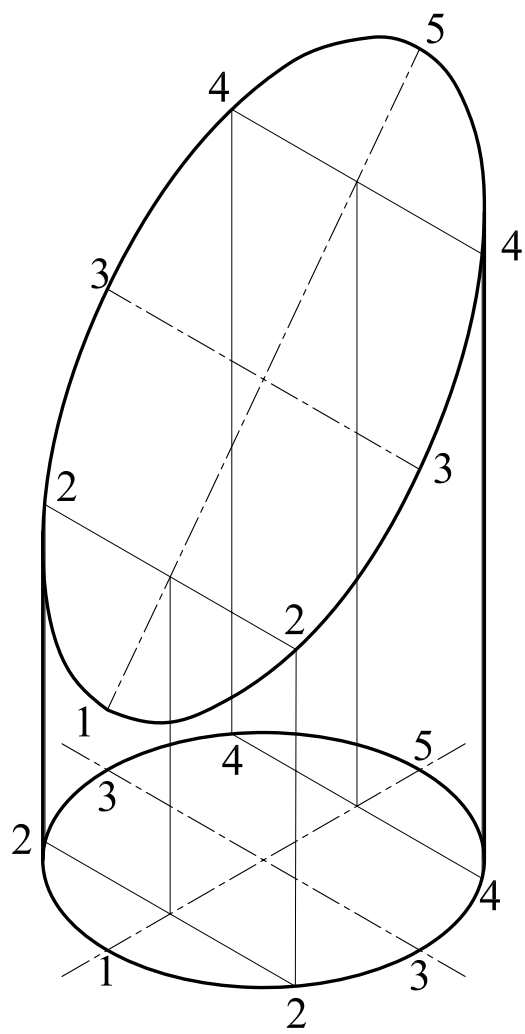


1

# PROJECTION OF OBLIQUE CURVE

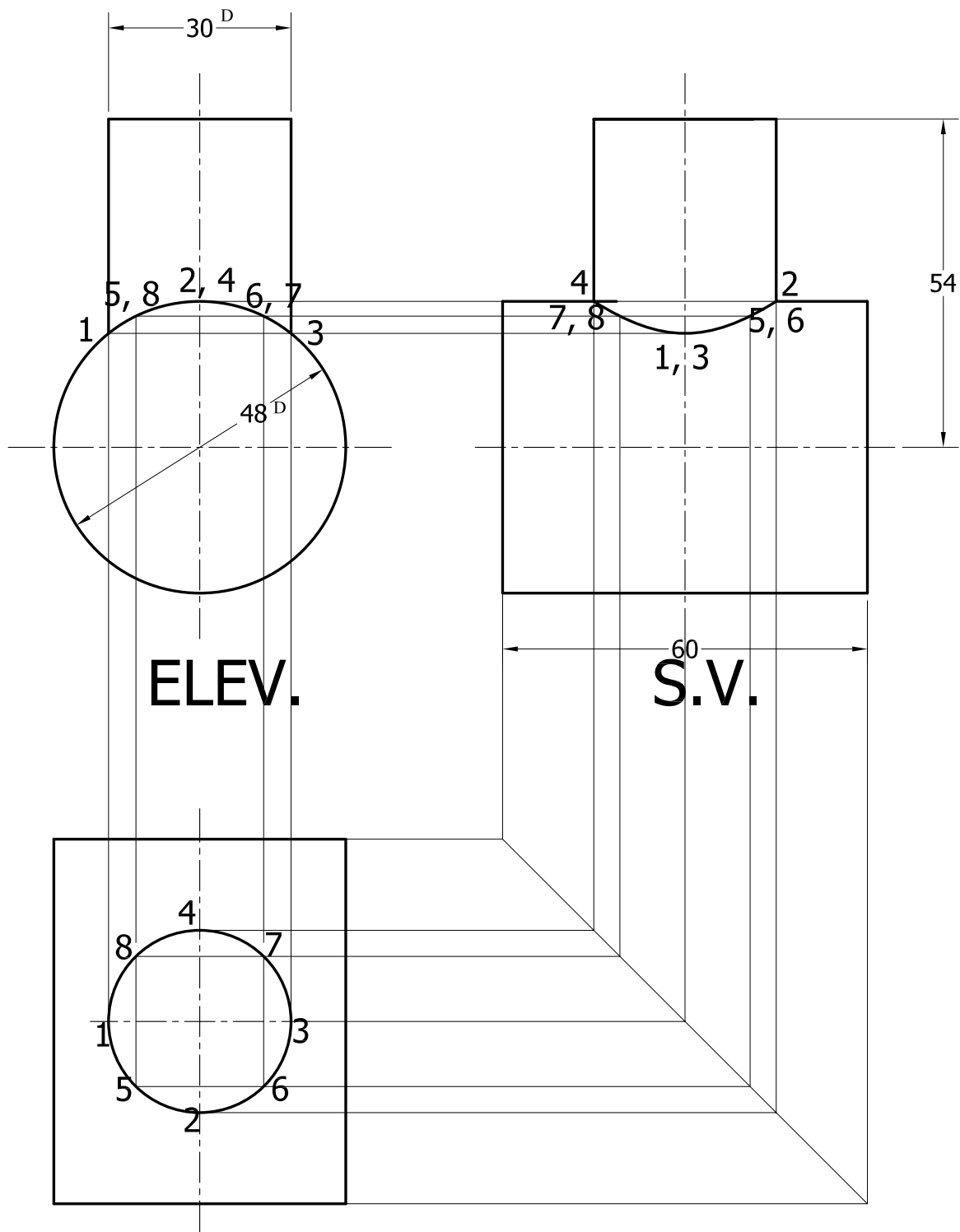
GIVEN: ELEVATION AND PLAN

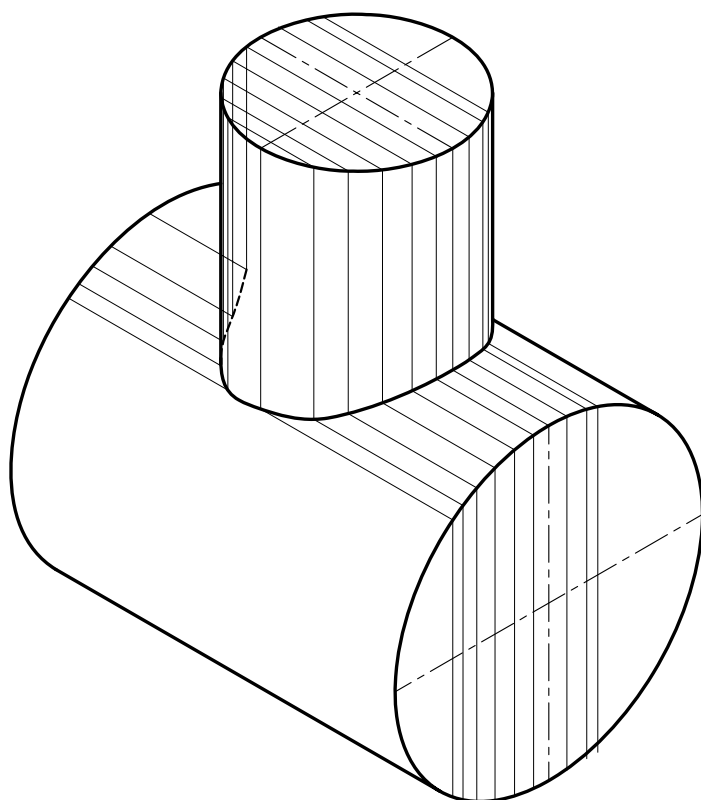




## Intersection curve of two cylinders (case1)

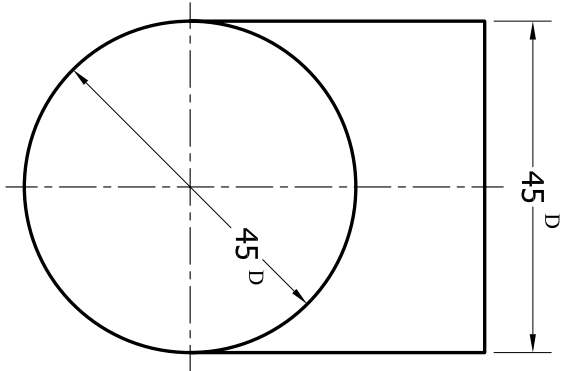
**GIVEN: ELEVATION AND PLAN**



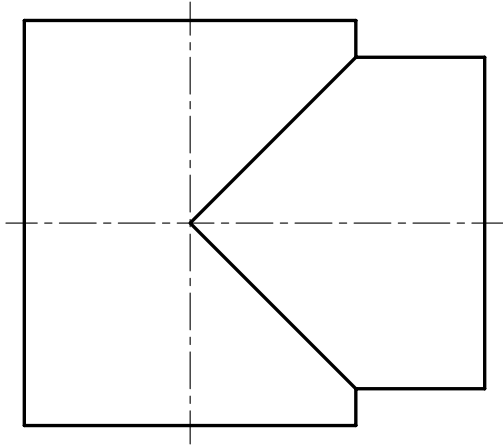


**Intersection curve of two cylinders (case2)**

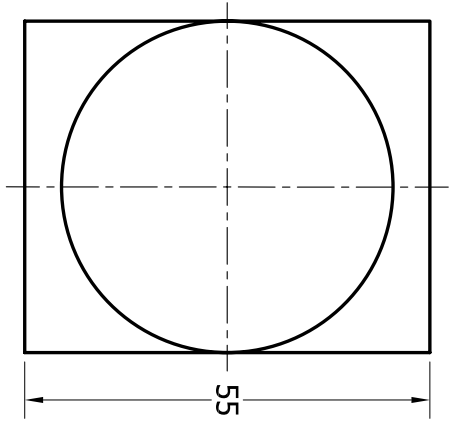
**GIVEN: ELEVATION AND PLAN**



**ELEV.**

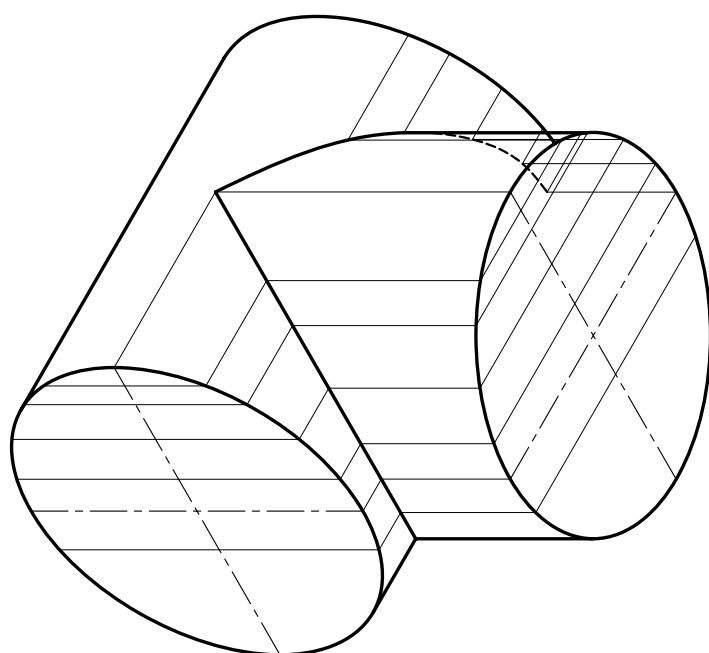


**S.V.**



**PLAN**

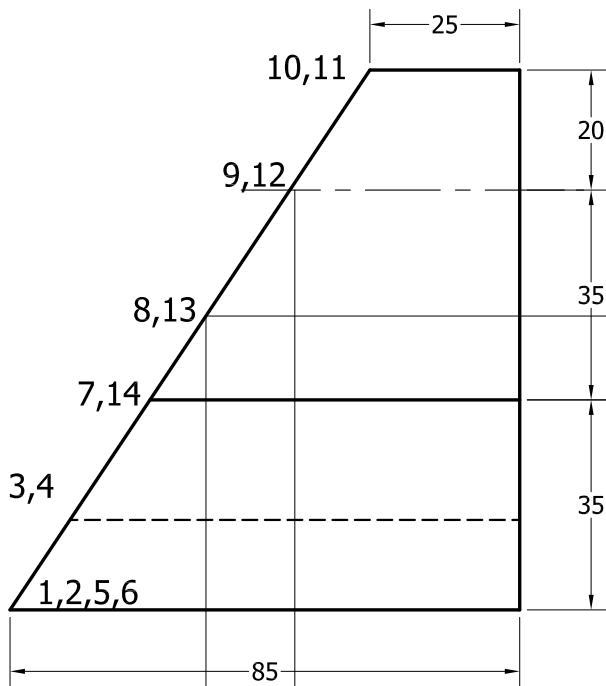




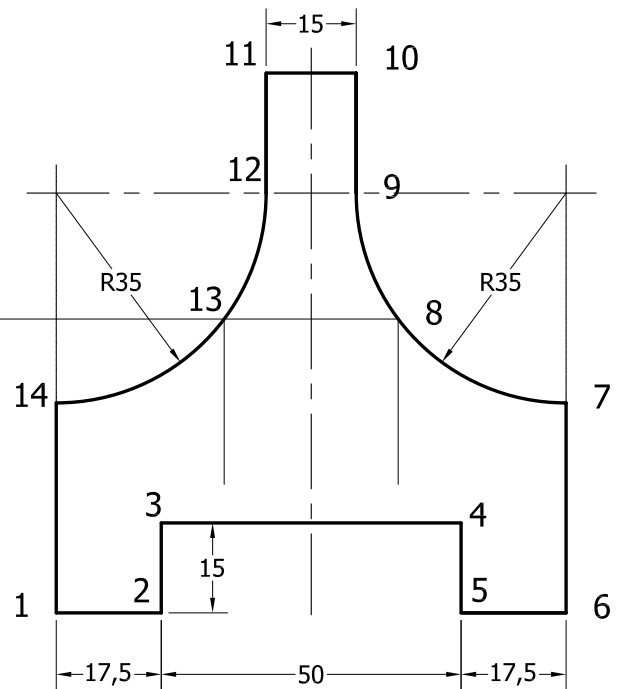
3

# PROJECTION OF OBLIQUE CURVE

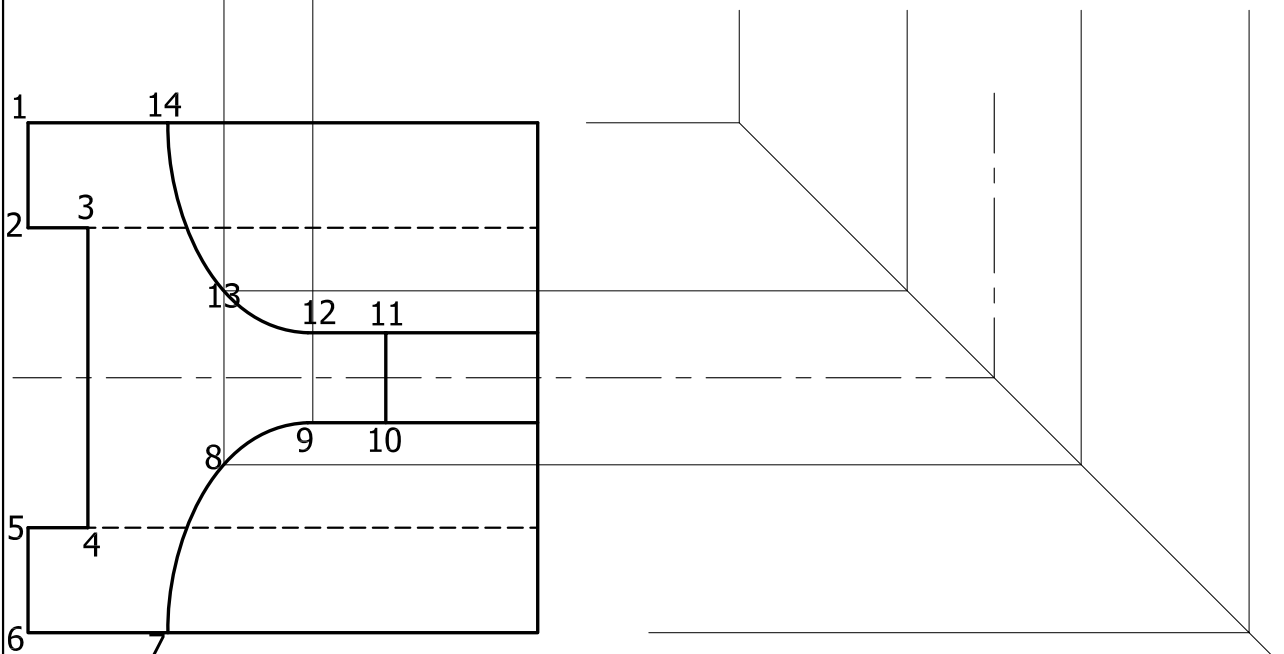
GIVEN: ELEVATION AND SIDE VIEW



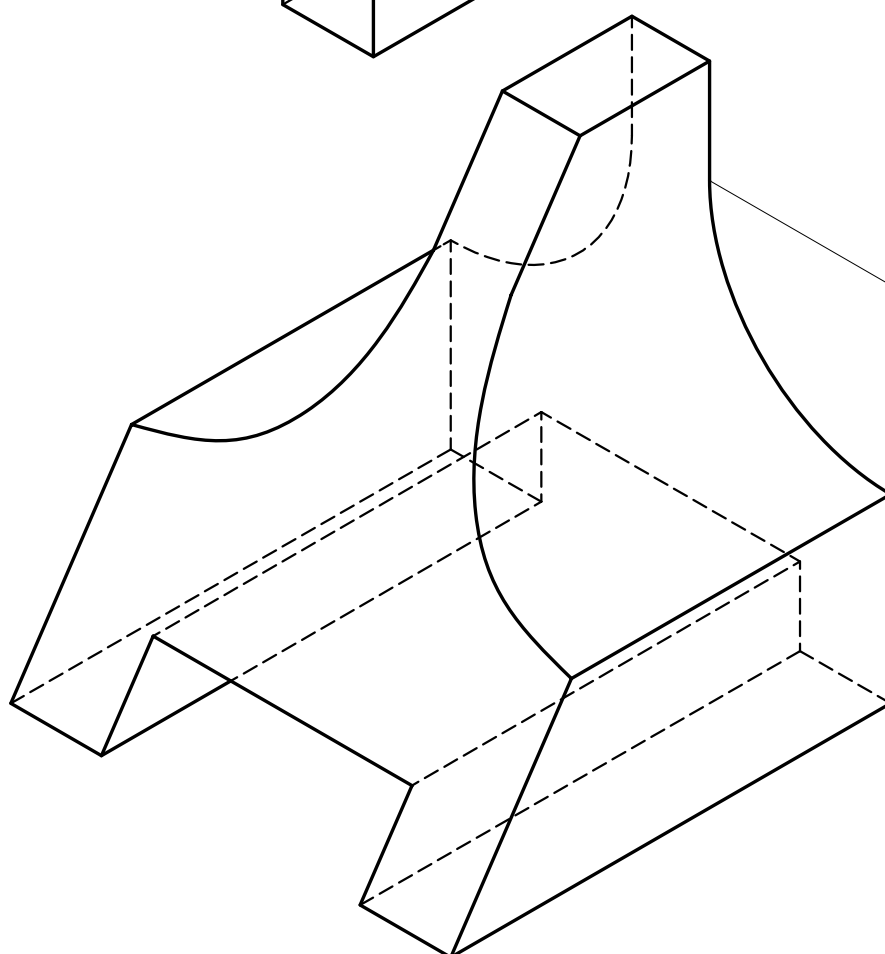
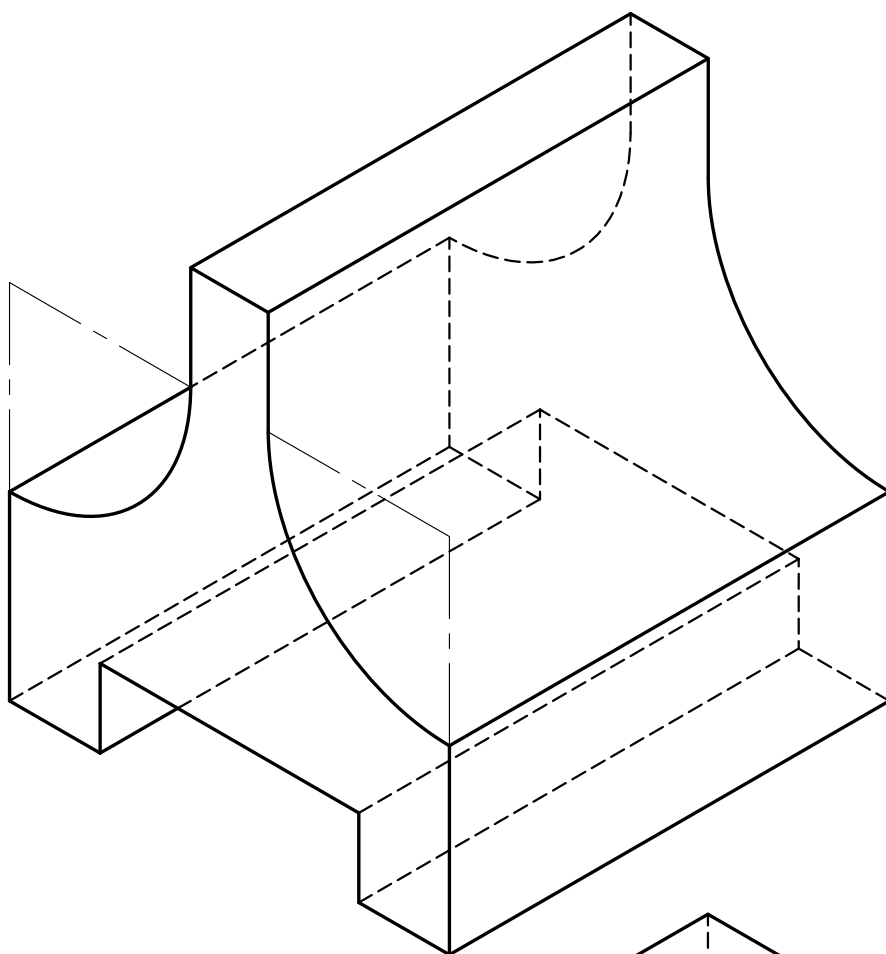
ELEVATION



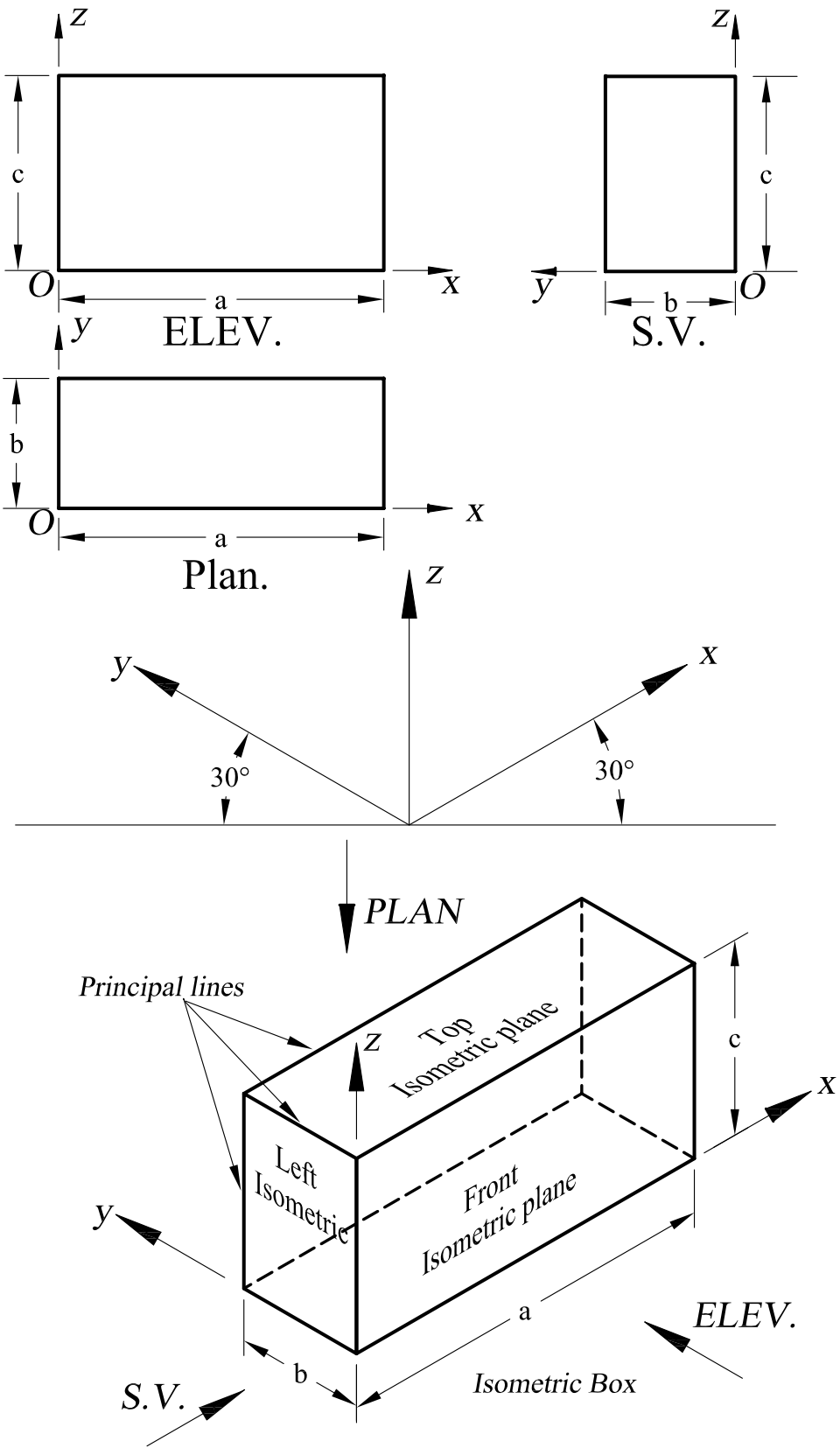
SIDE VIEW

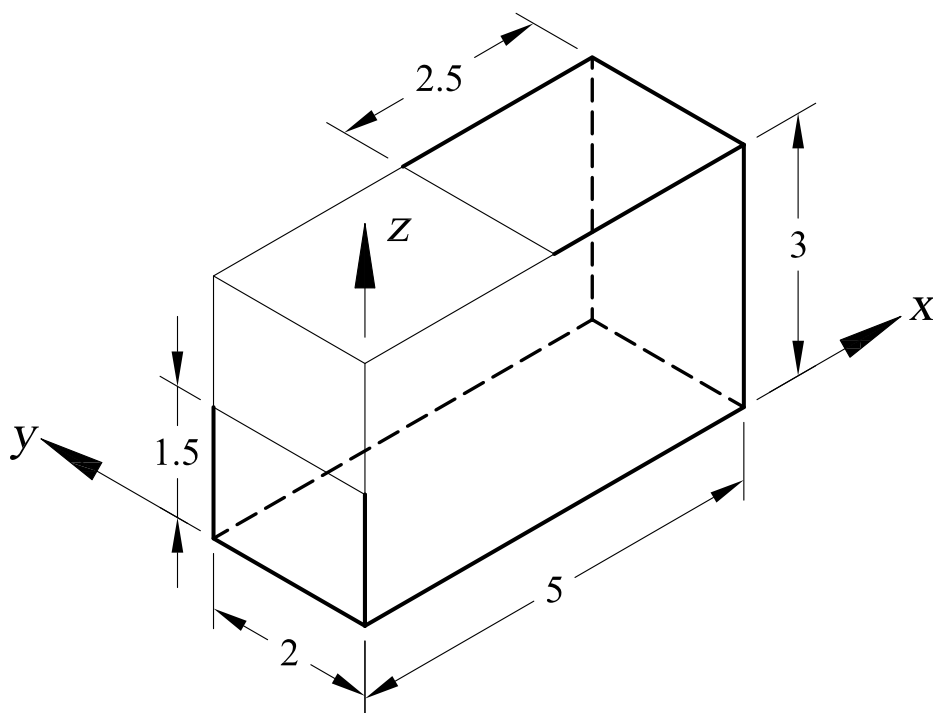
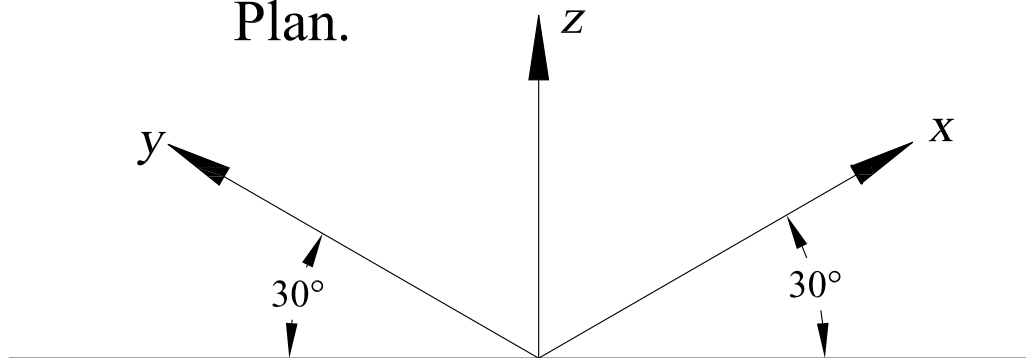
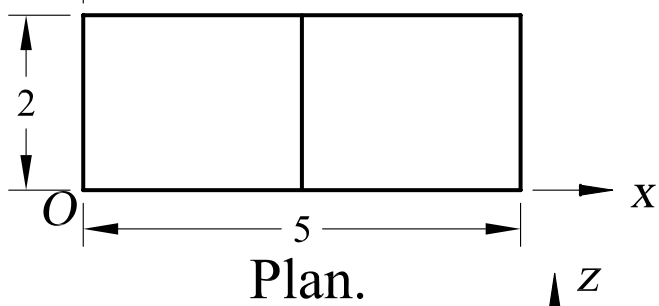
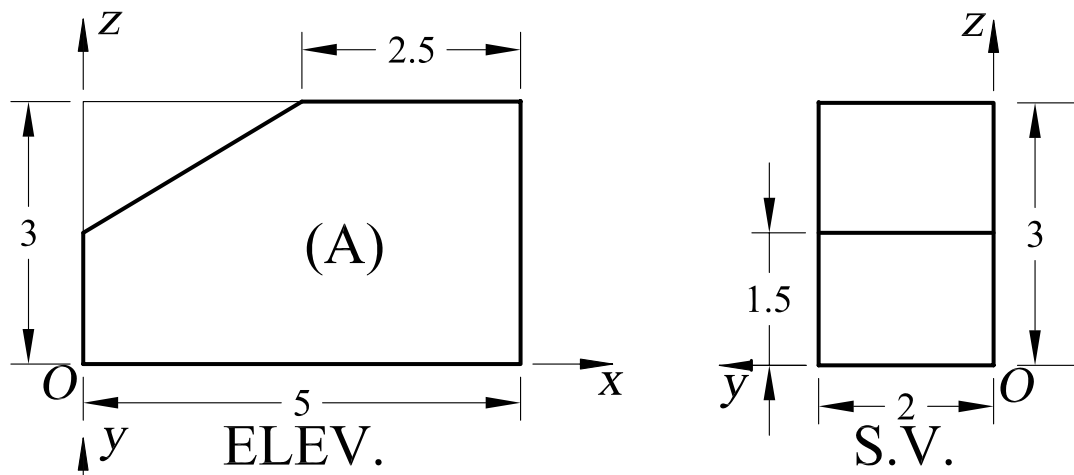


PLAN



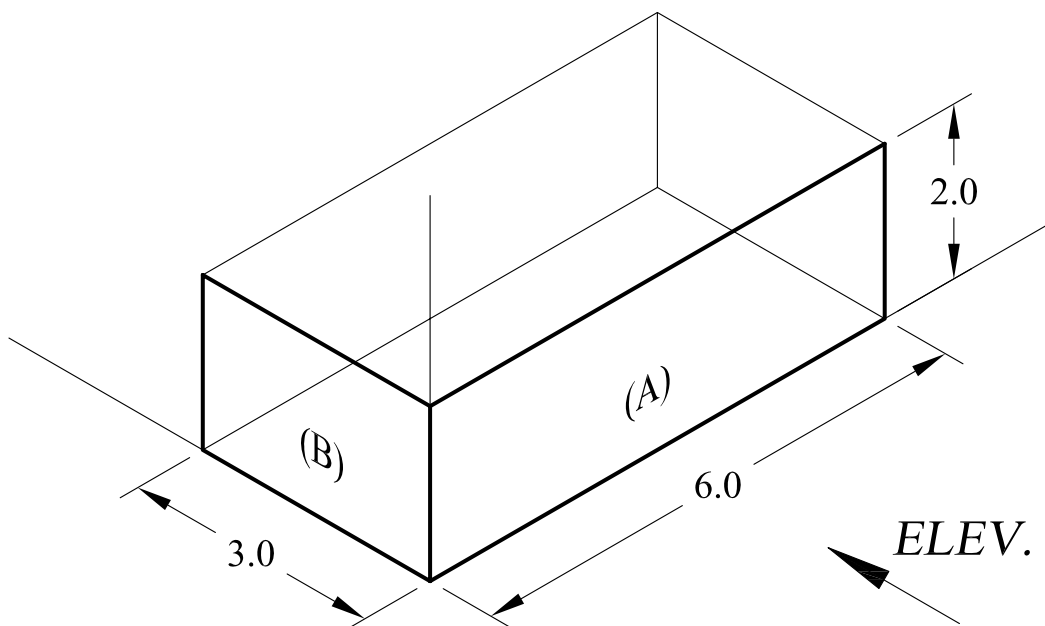
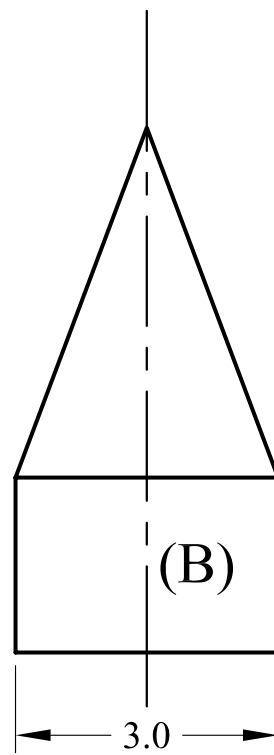
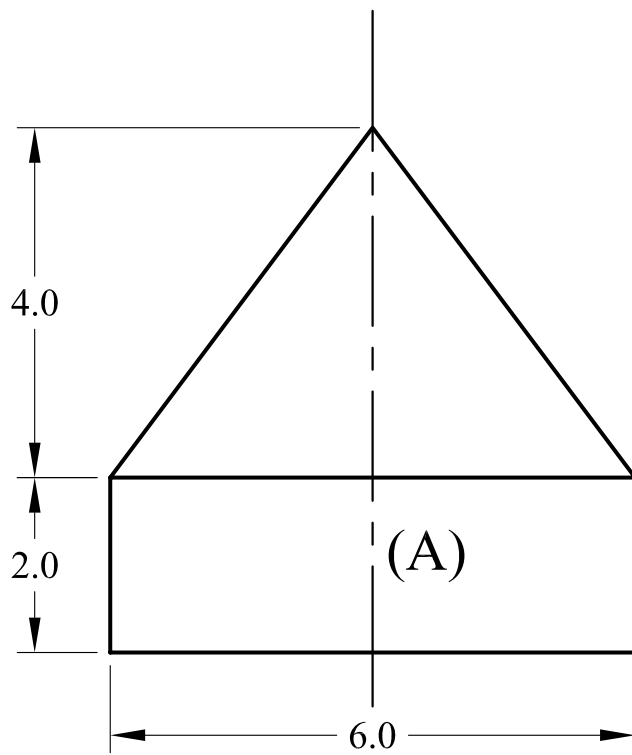
# ISOMETRIC VIEWS

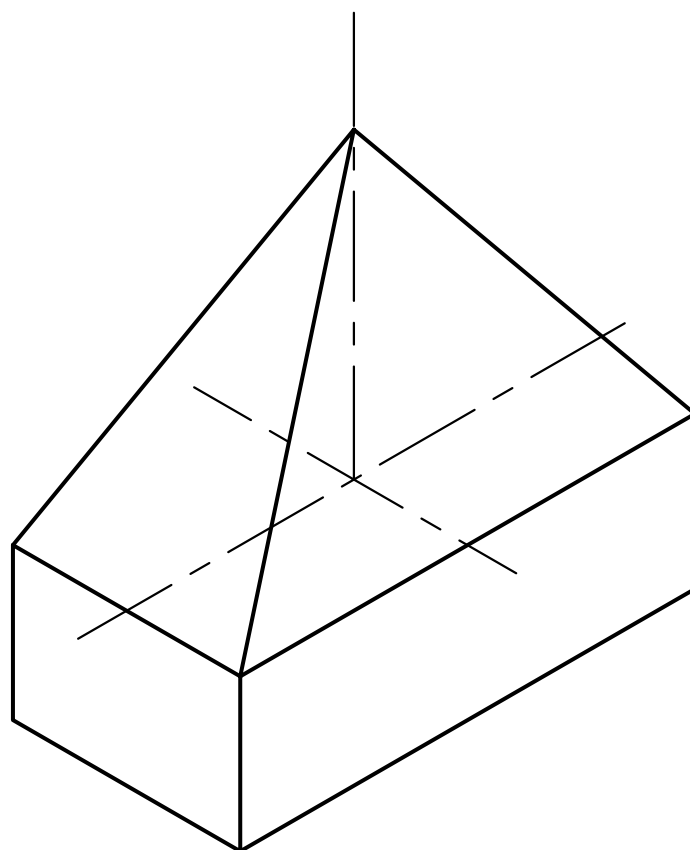
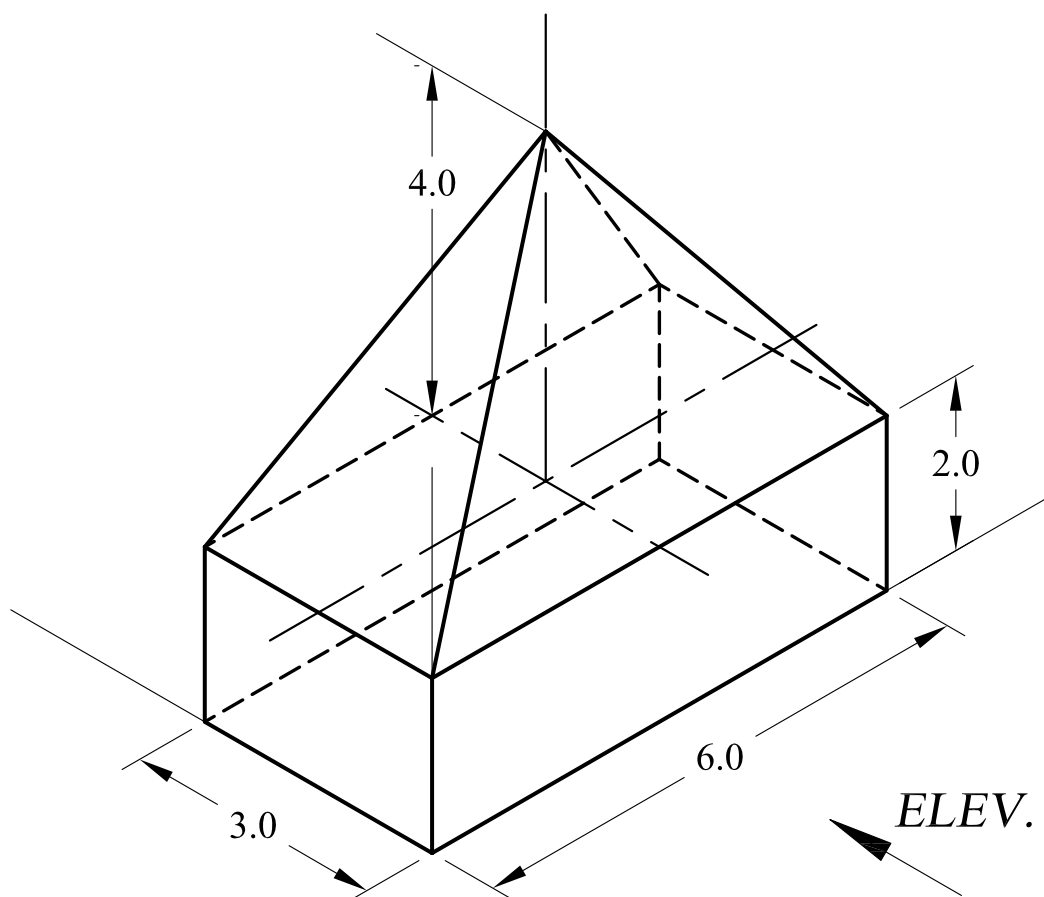




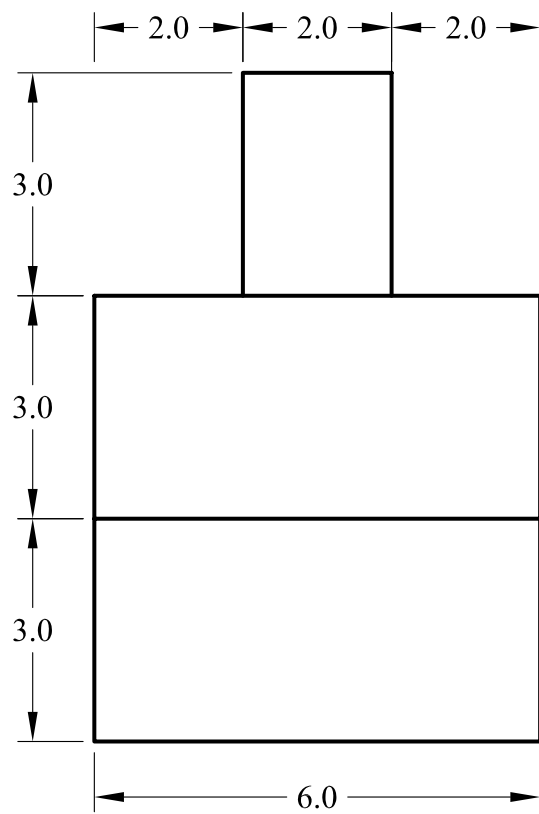
*Complete Isometric Box*



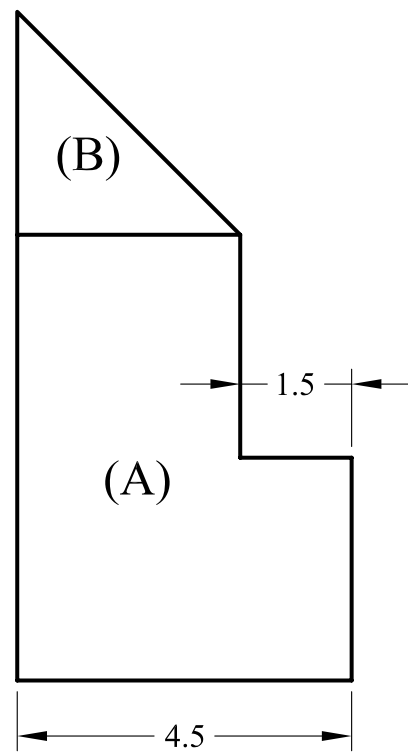




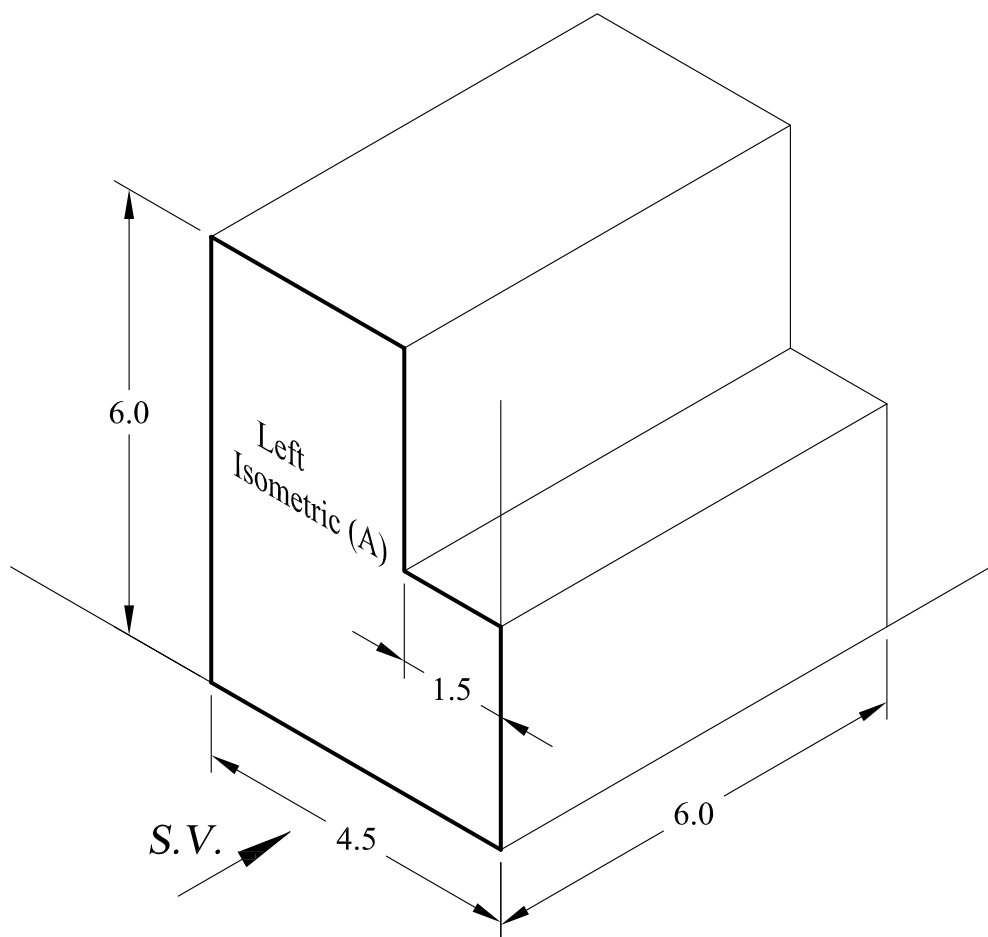


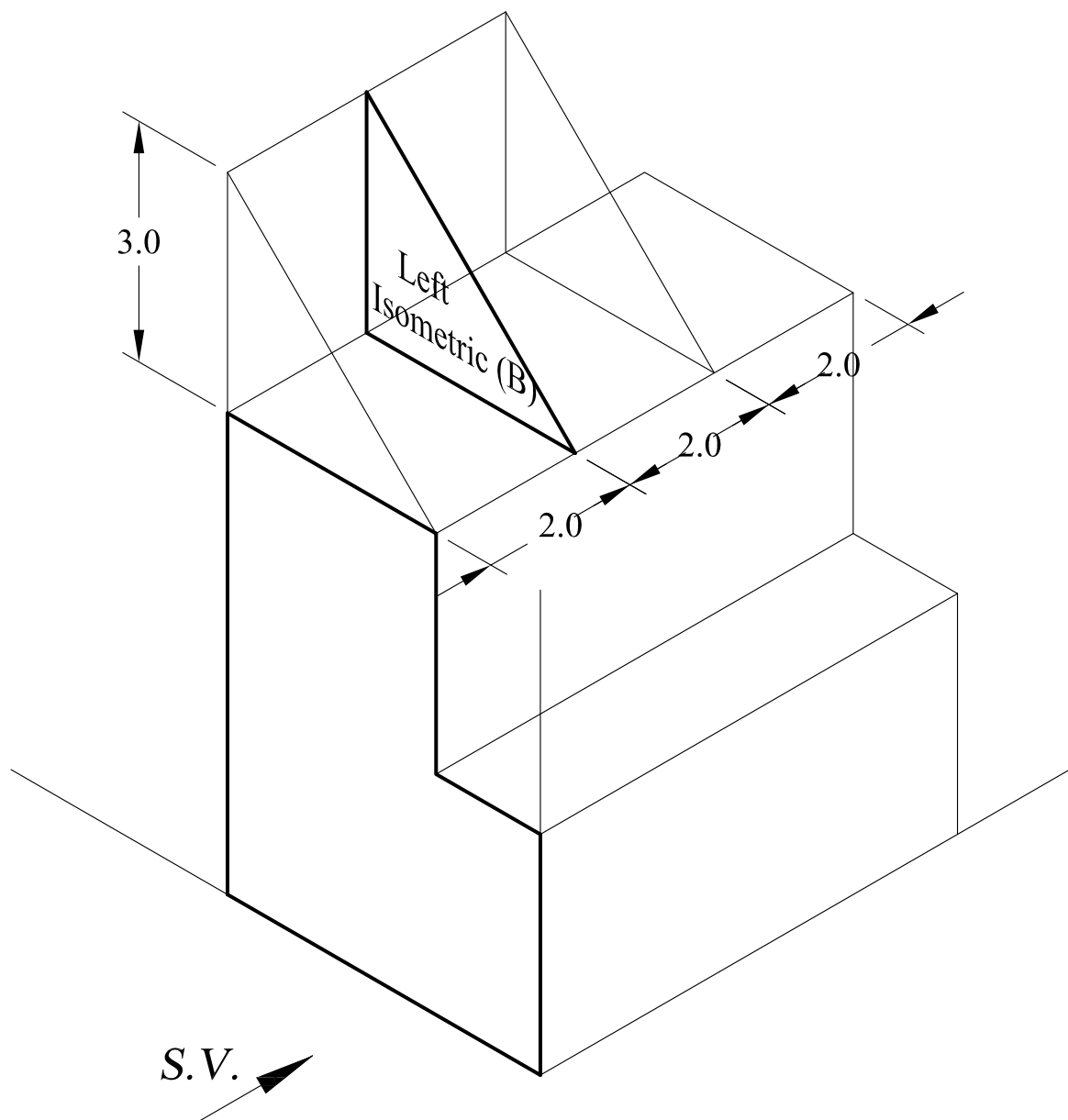


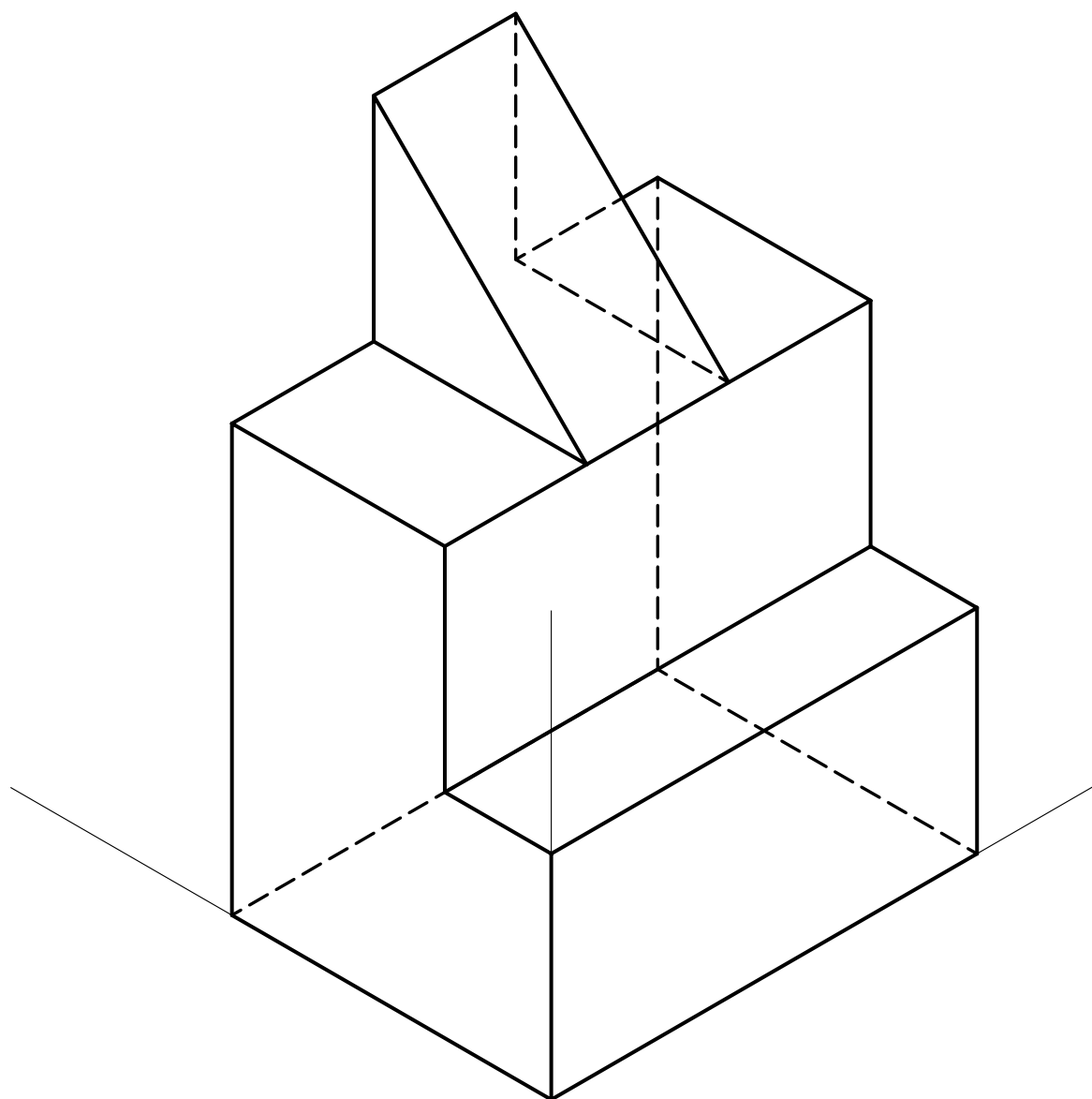
ELEV.

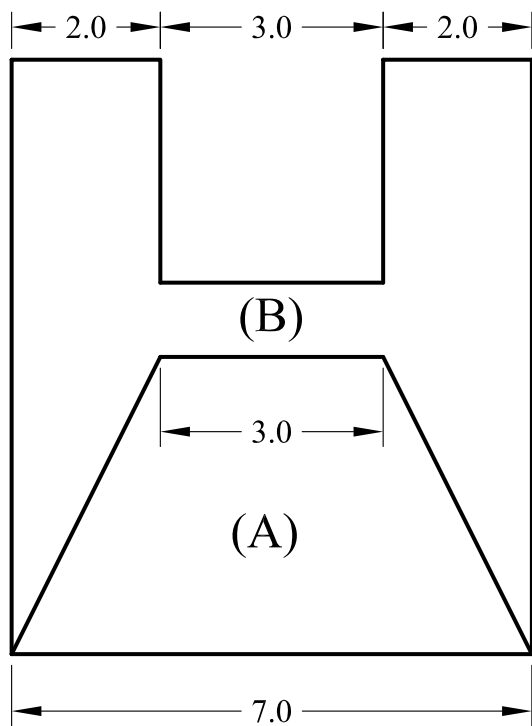


S.V.

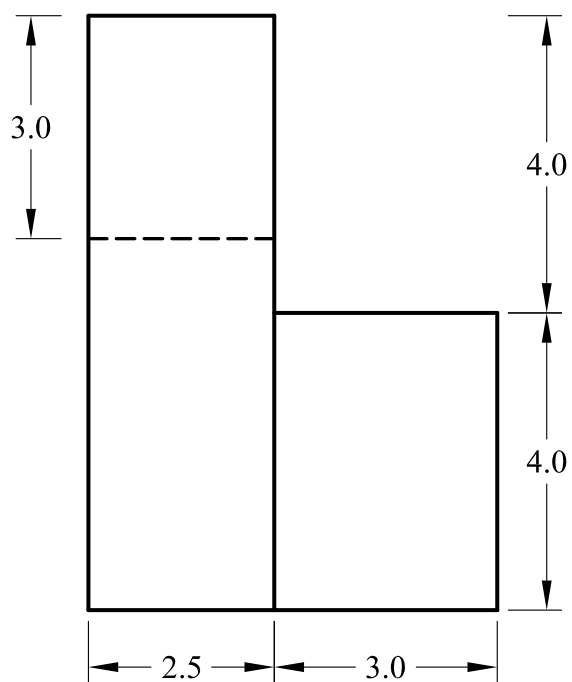




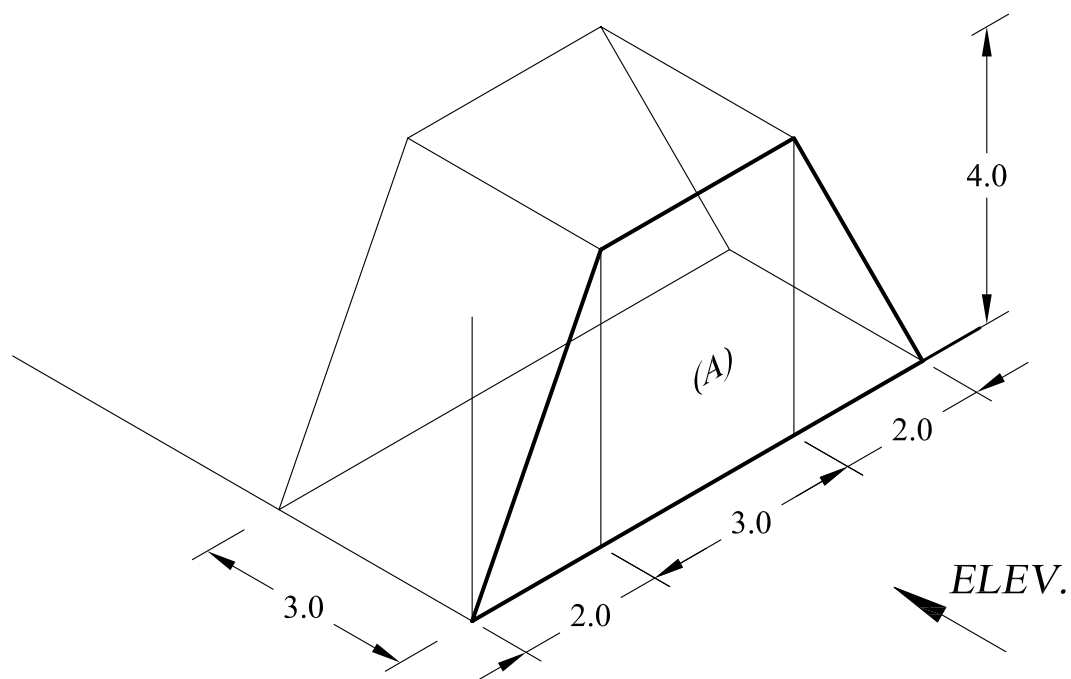




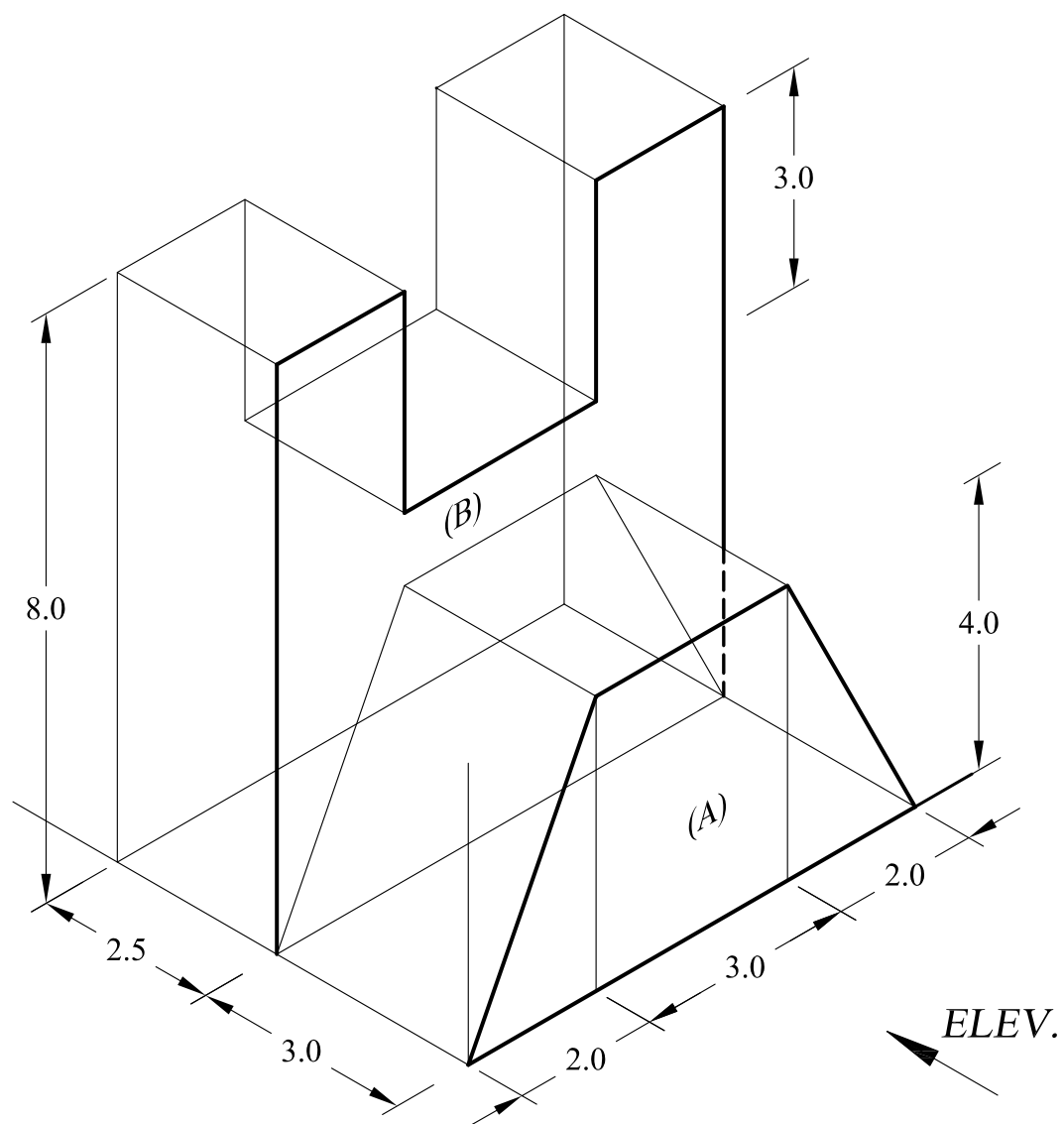
ELEV.

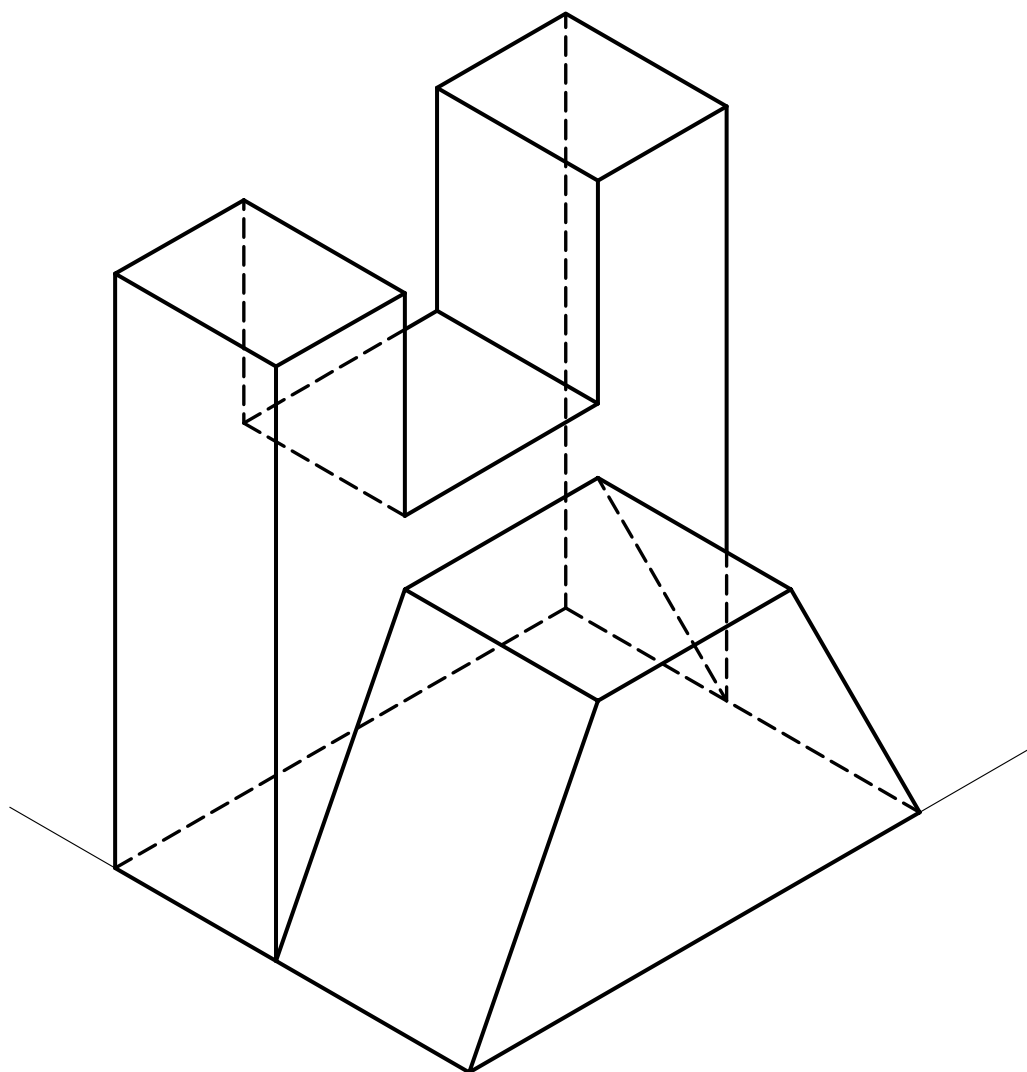


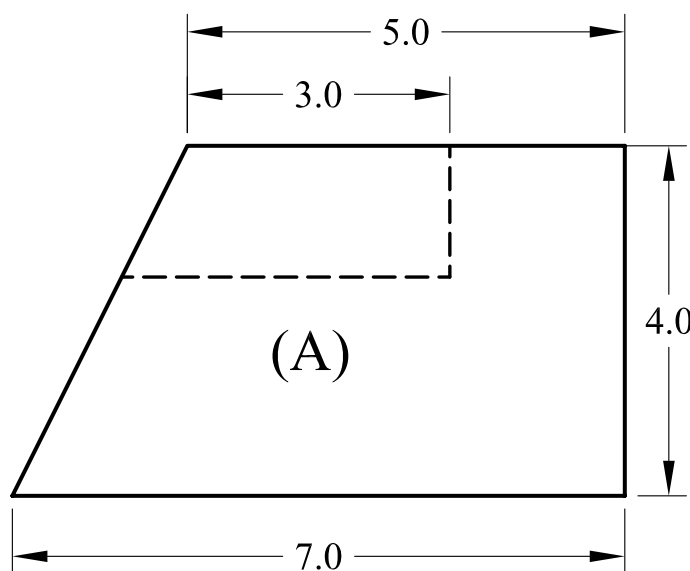
S.V.



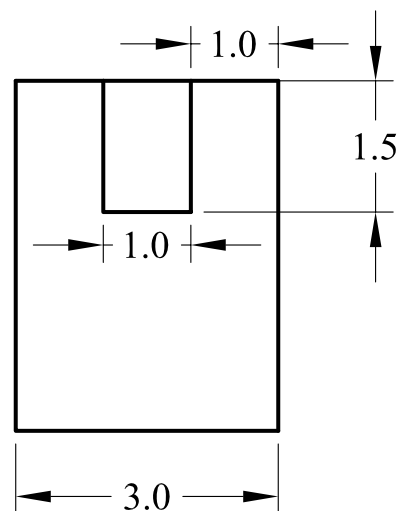
ELEV.



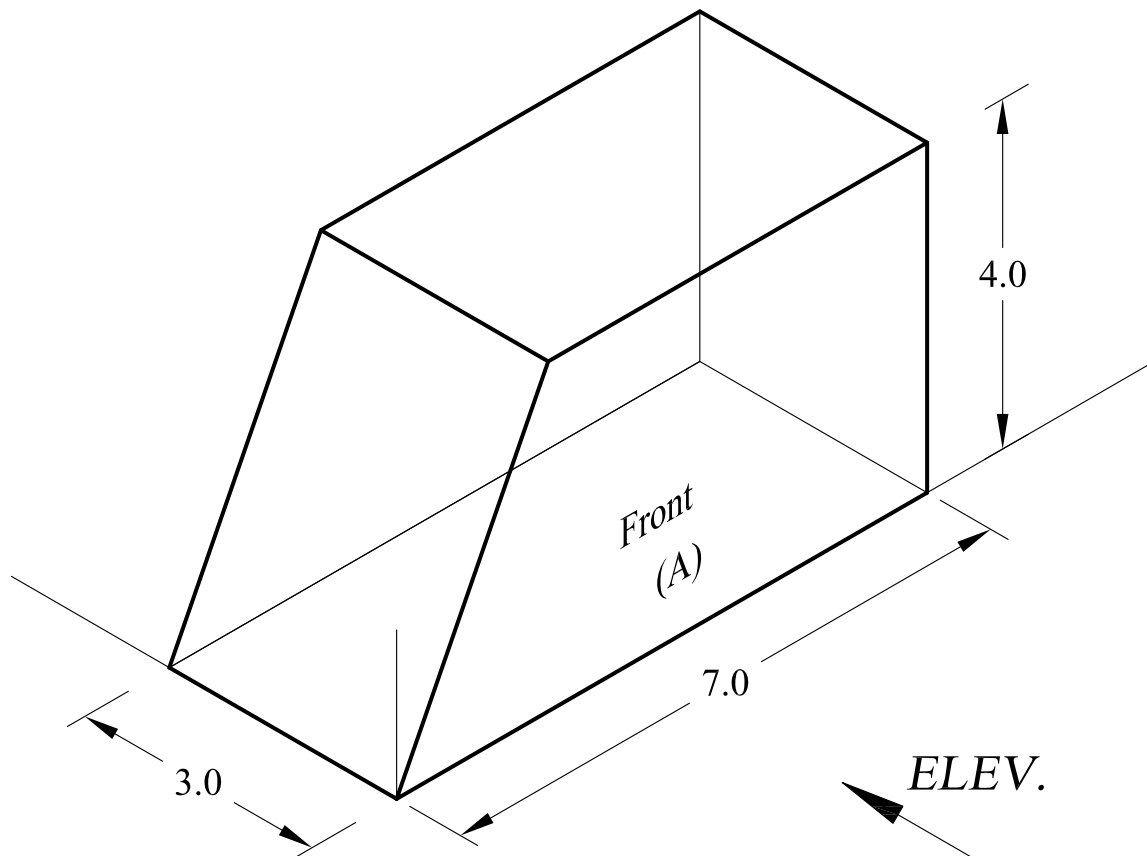




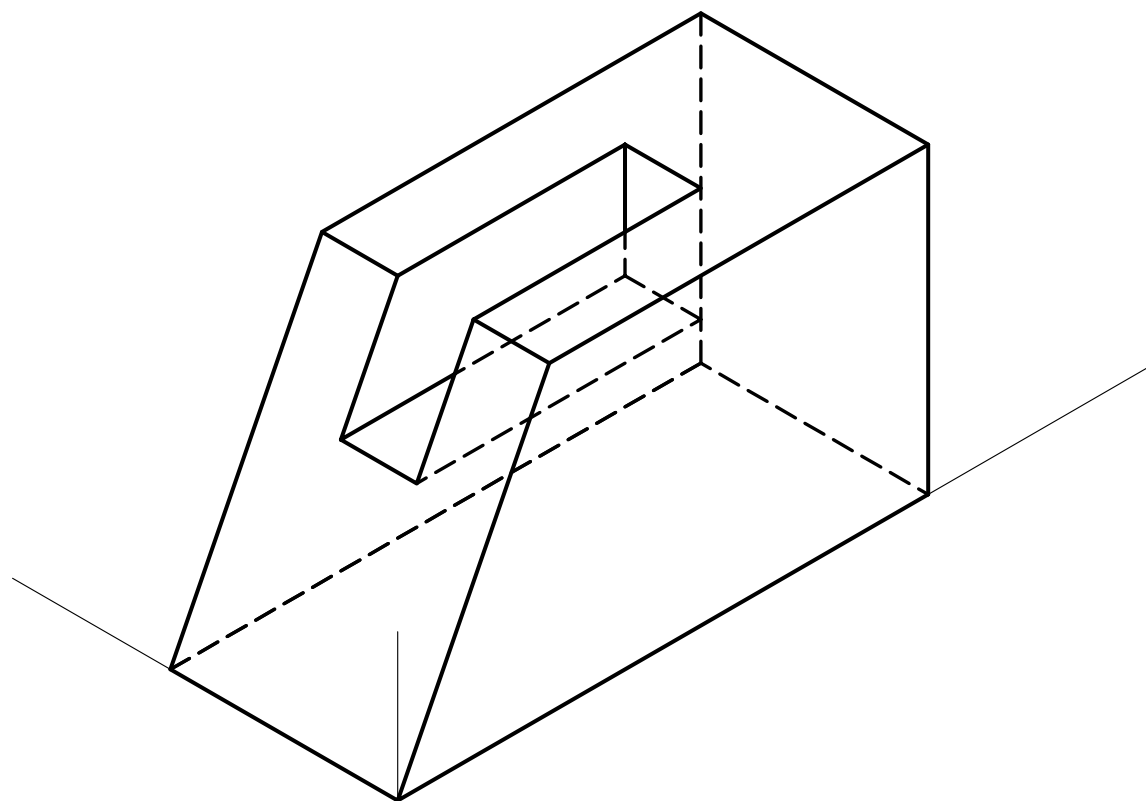
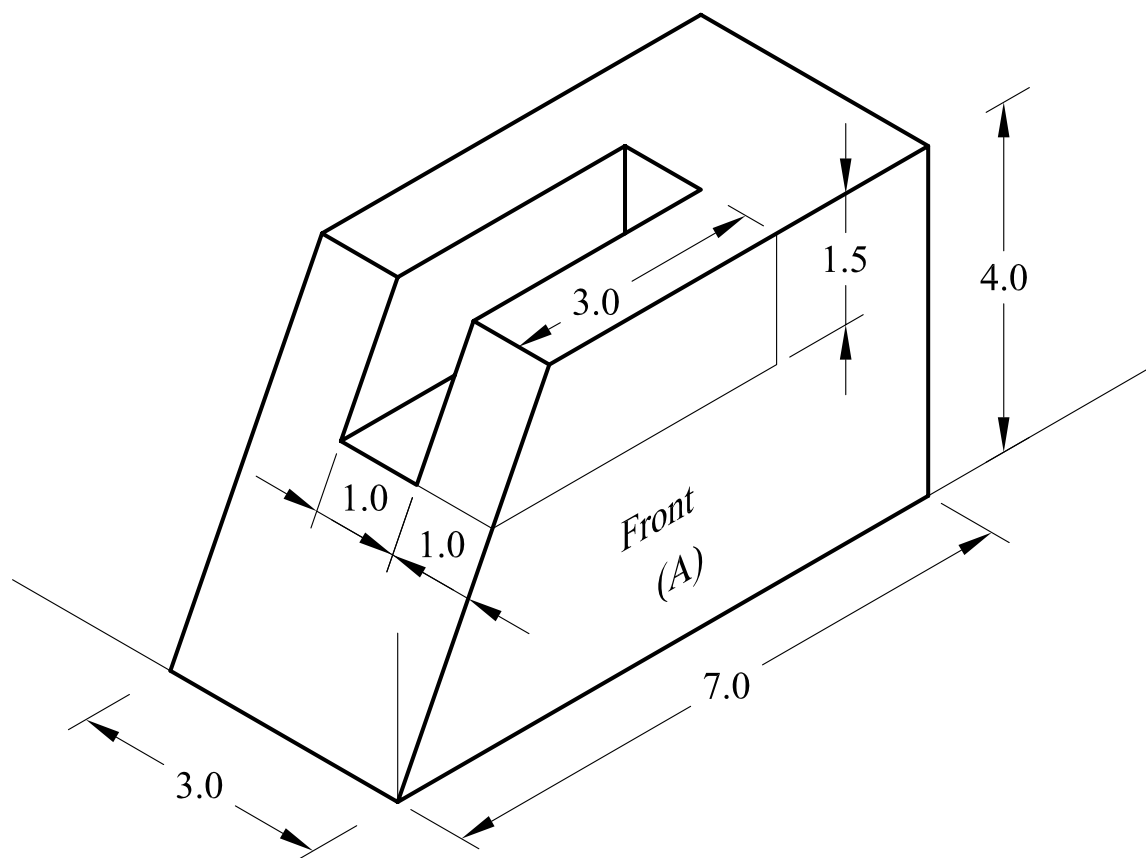
ELEV.



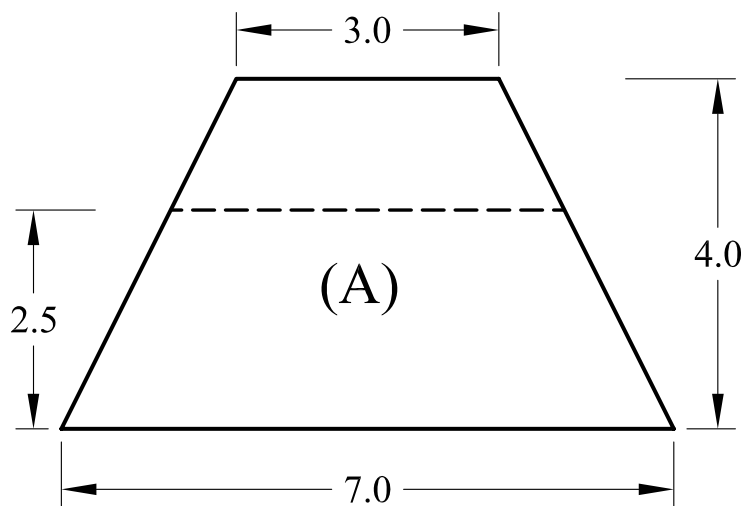
S.V.



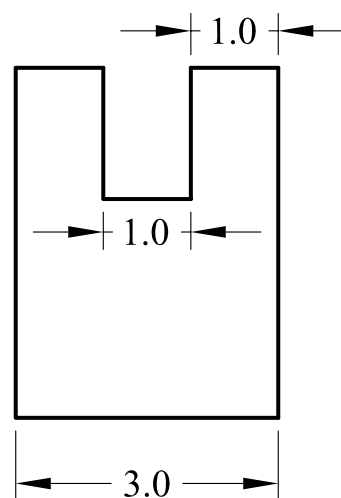
ELEV.



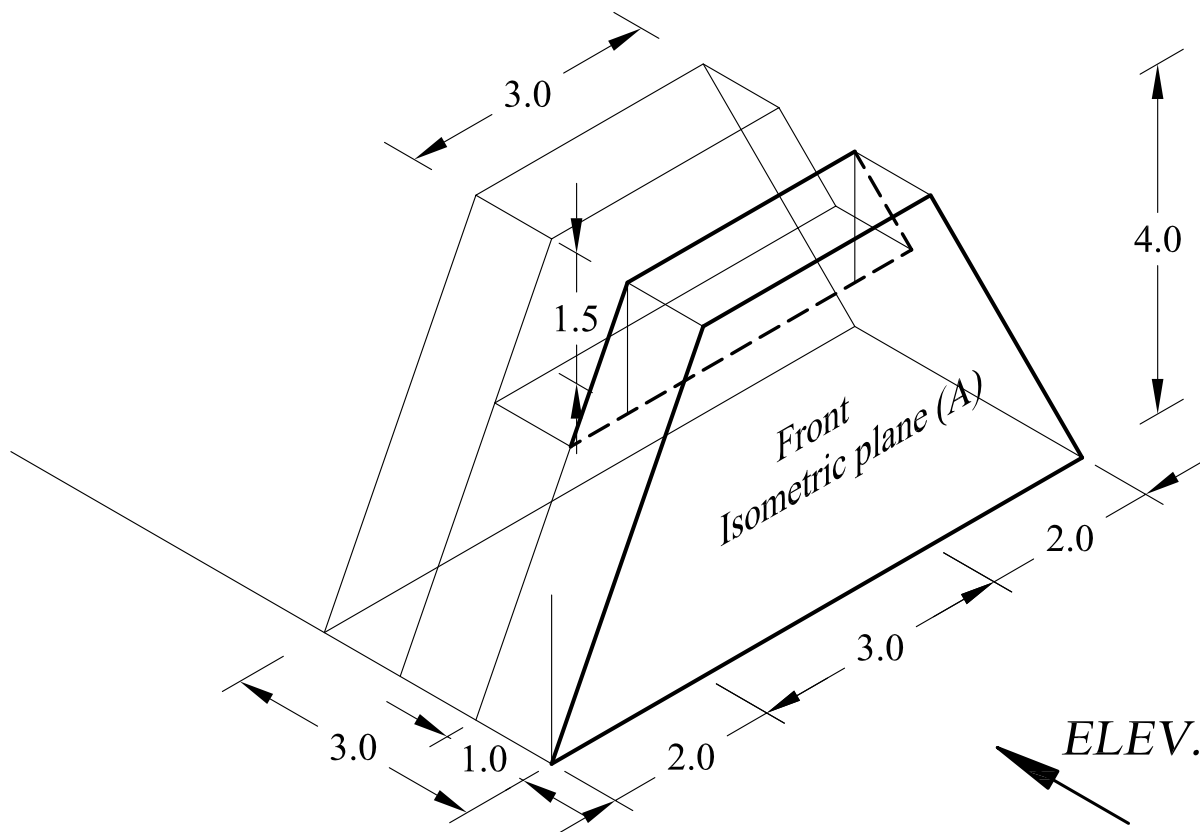




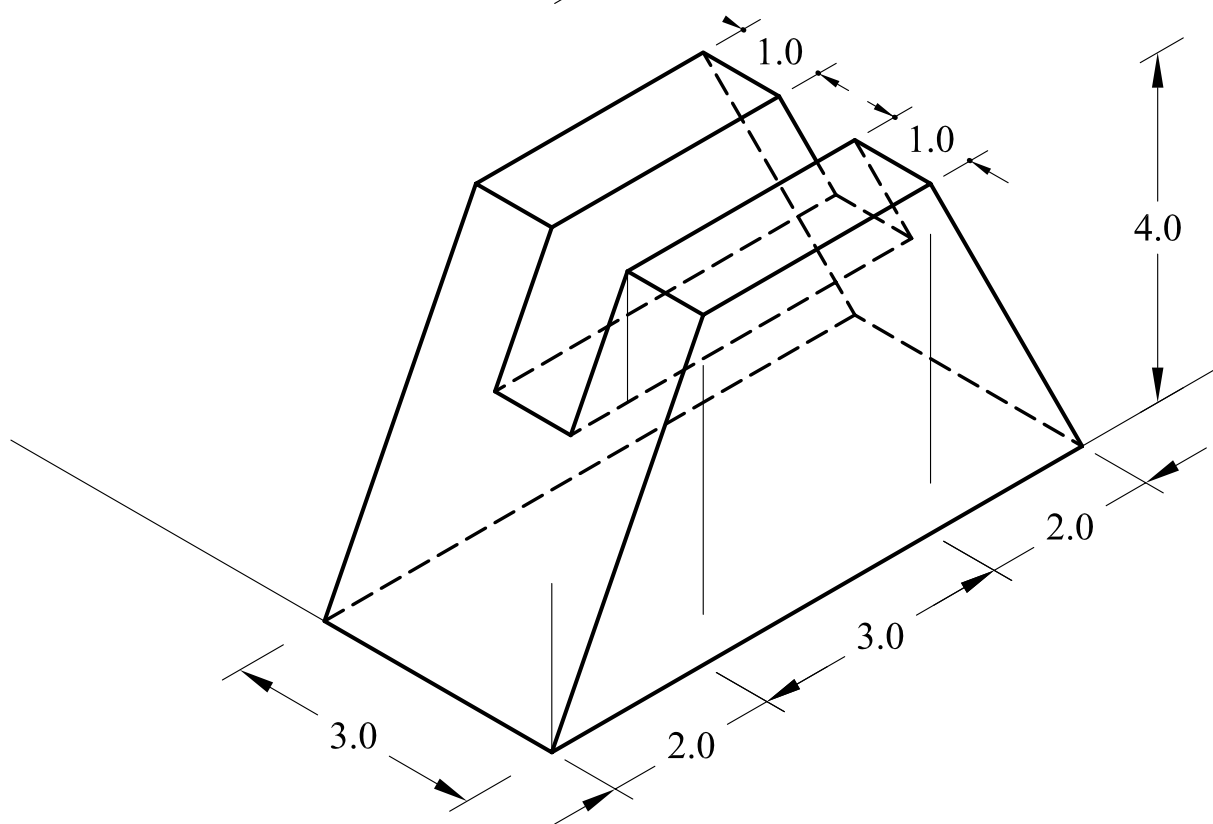
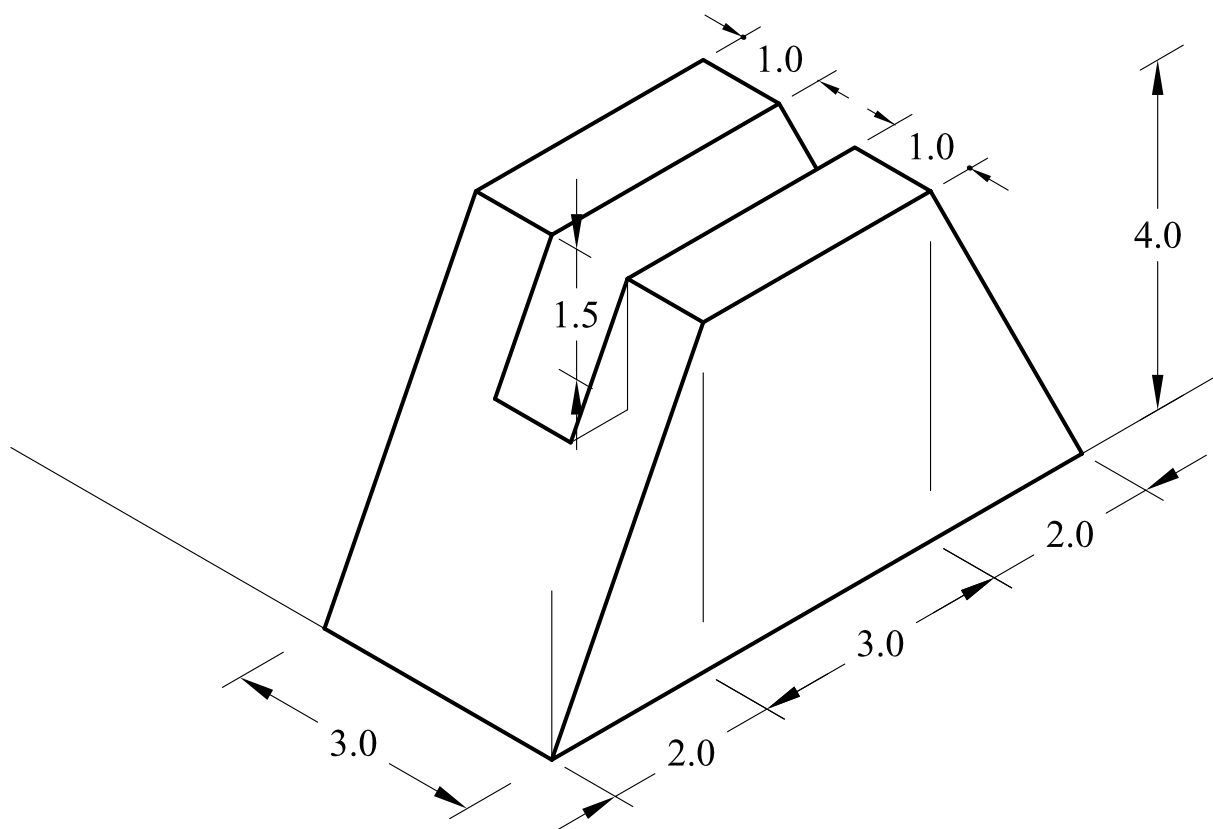
ELEV.



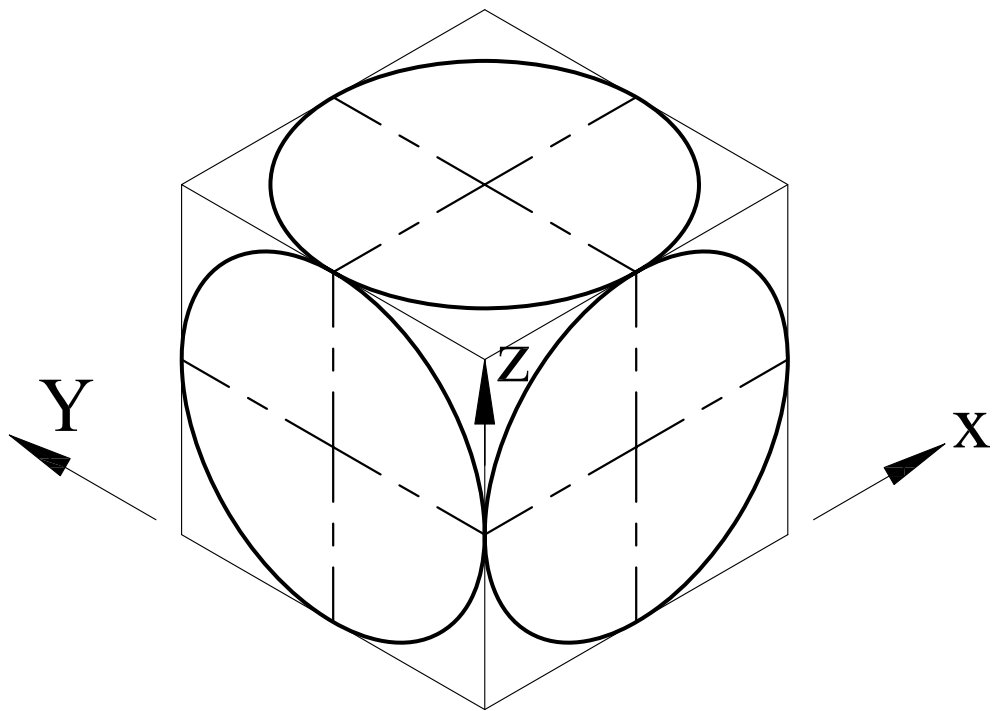
S.V.



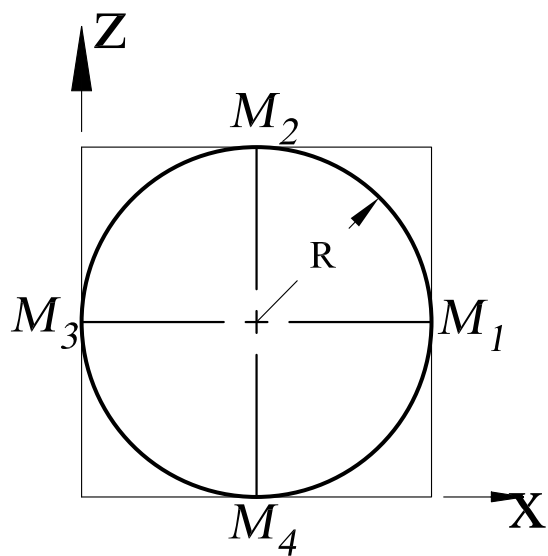
ELEV.



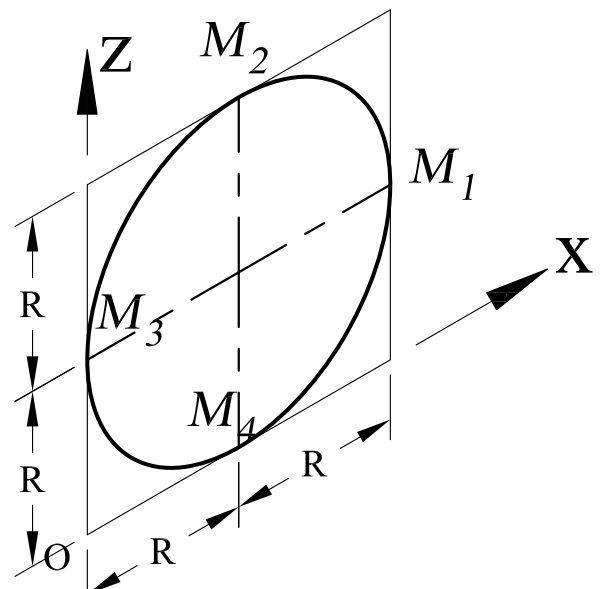
# ISOMETRIC CIRCLES



Isometric circles

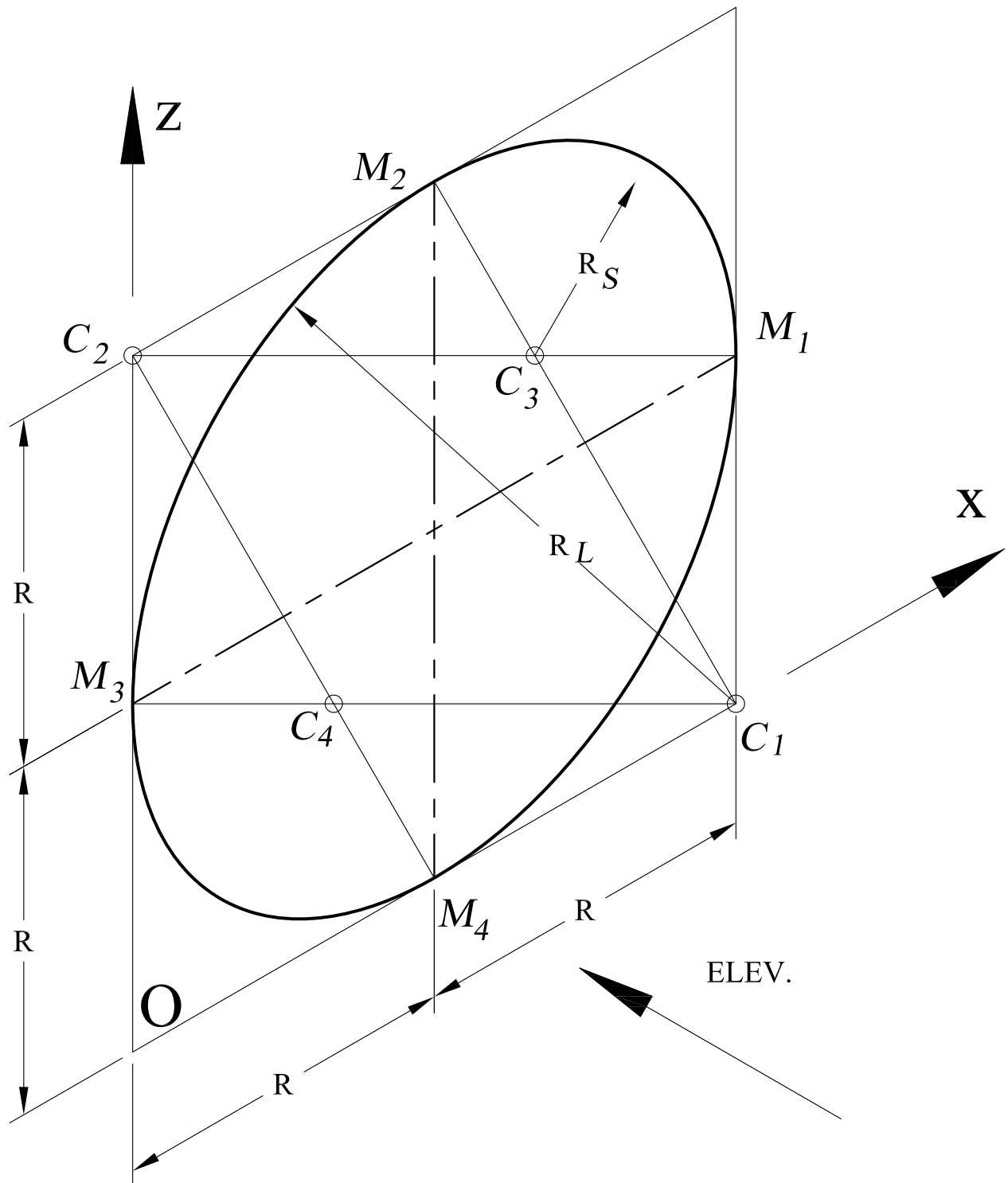


ELEVATION



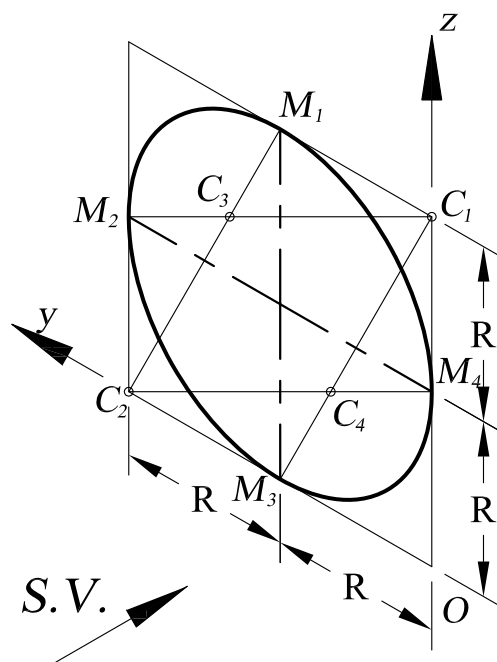
Isometric Front Circles

# ISOMETRIC CIRCLES



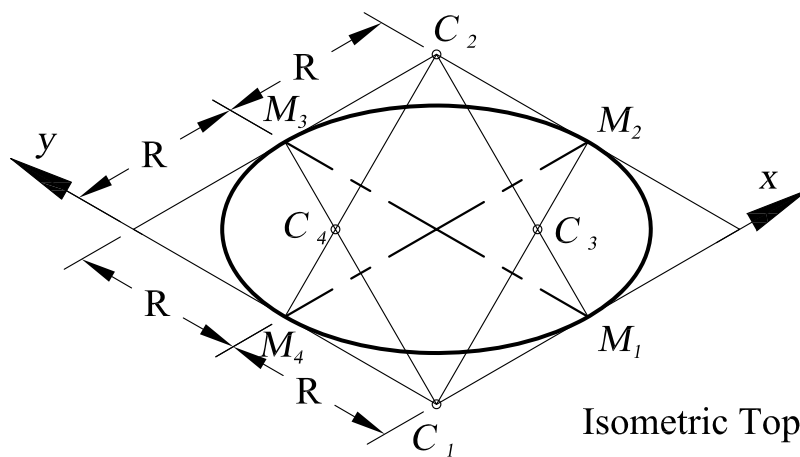
APPROXIMATE METHOD  
(Four Centers Method)

Isometric Front Circle



Isometric left (Side View) Circle

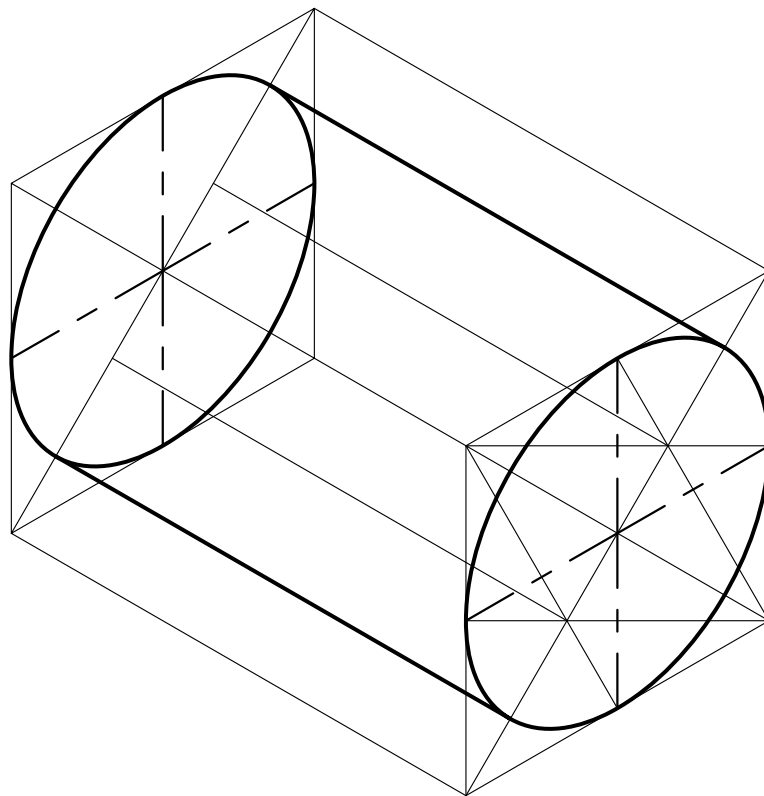
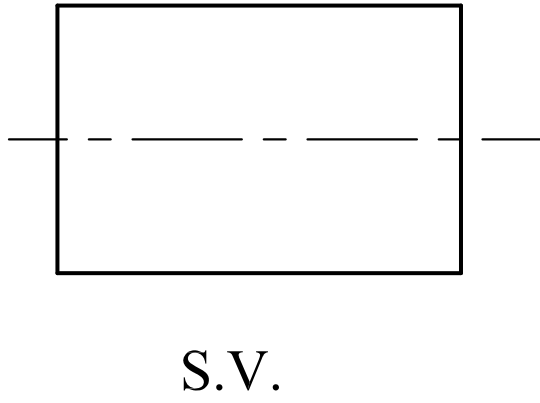
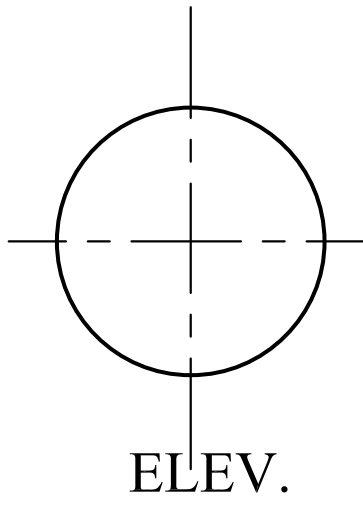
↓  
**PLAN**



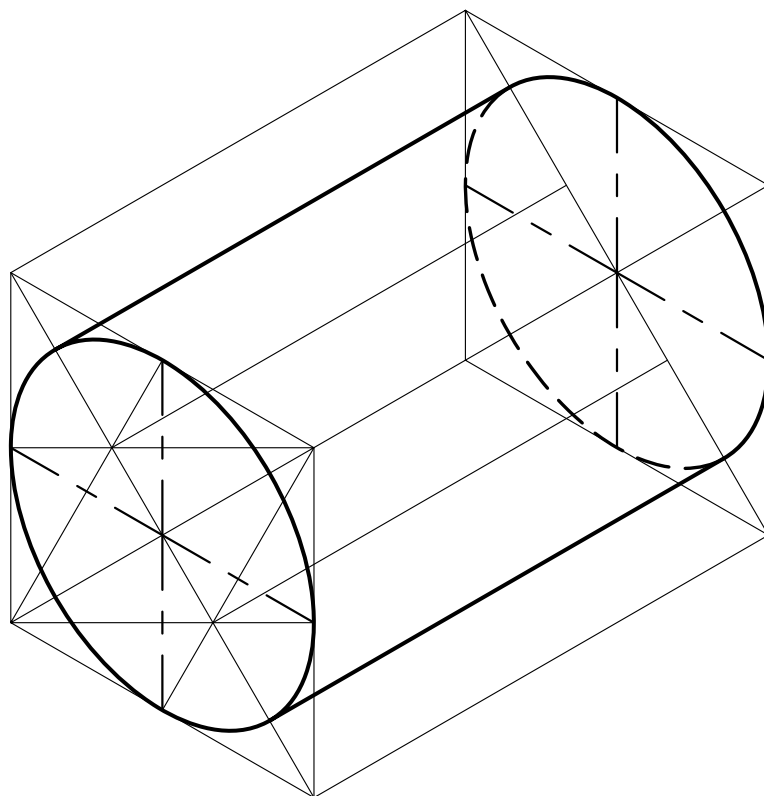
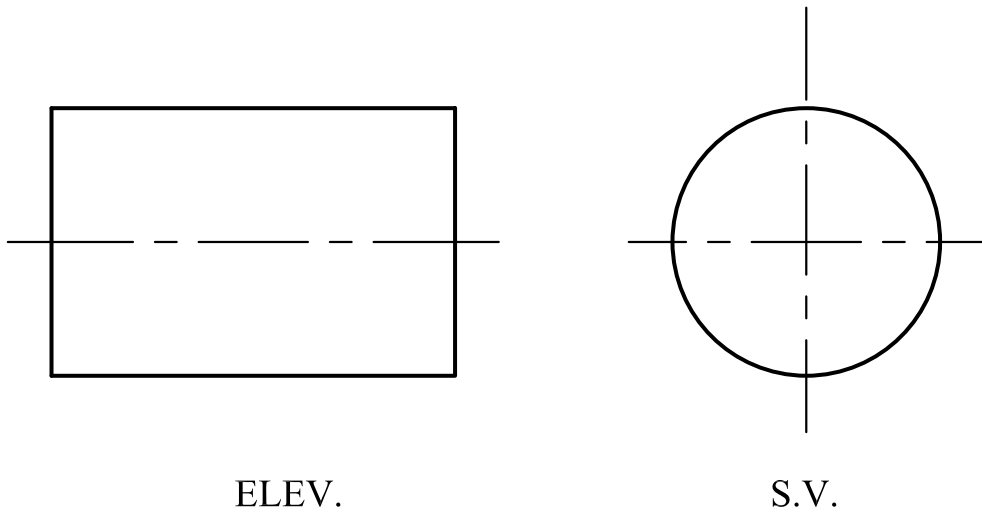
Isometric Top (PLAN) Circle

Construction of Isometric Circles

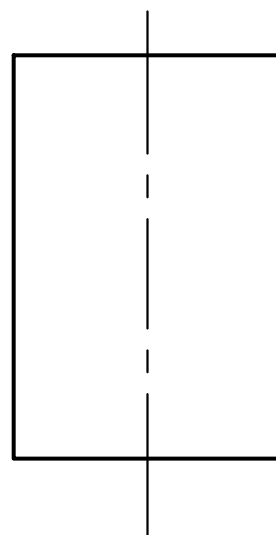
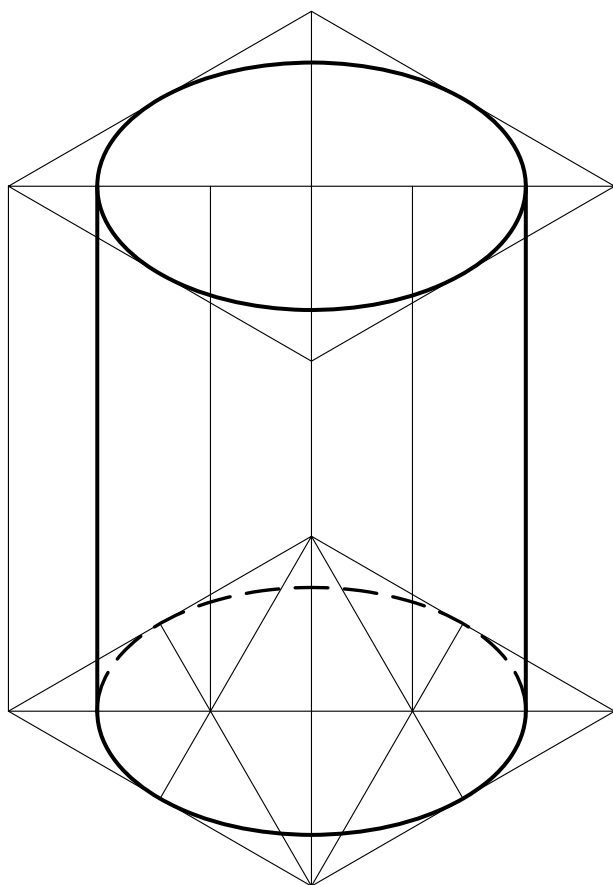
## ISOMETRIC CYLINDER



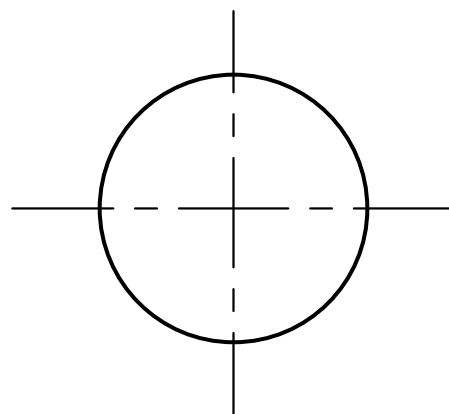
*Construction of Isometric Cylinder with Front Base*



Construction of Isometric Cylinder with Left Base



ELEV.

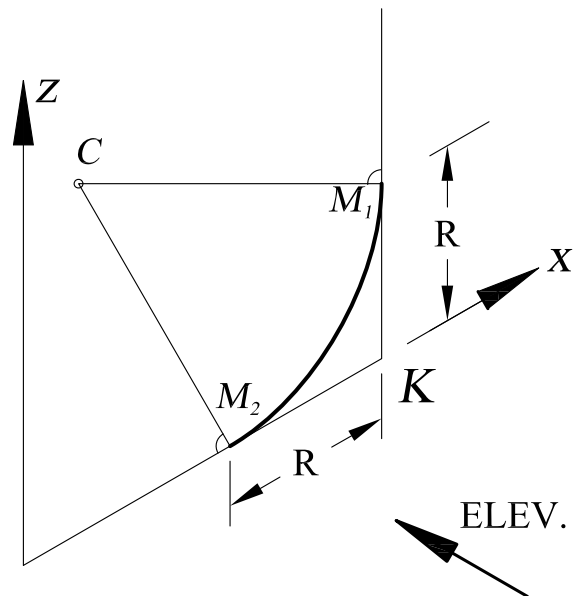
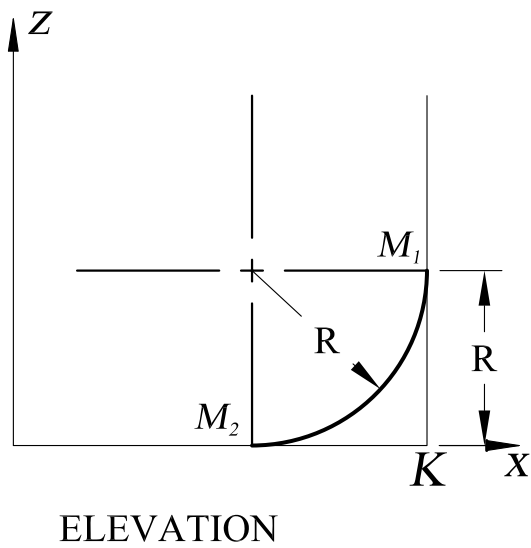
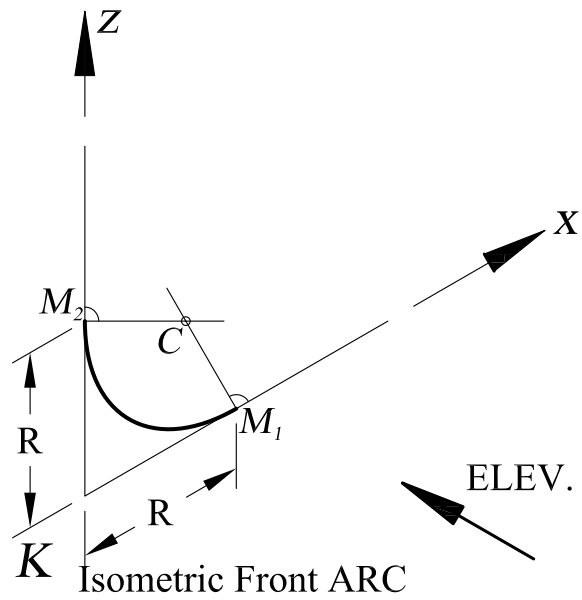
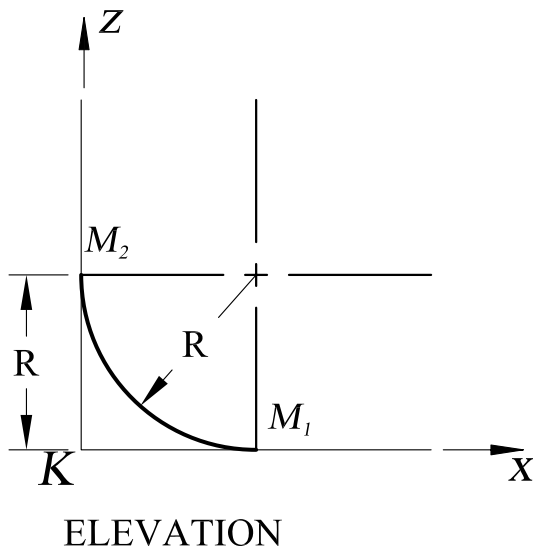


PLAN

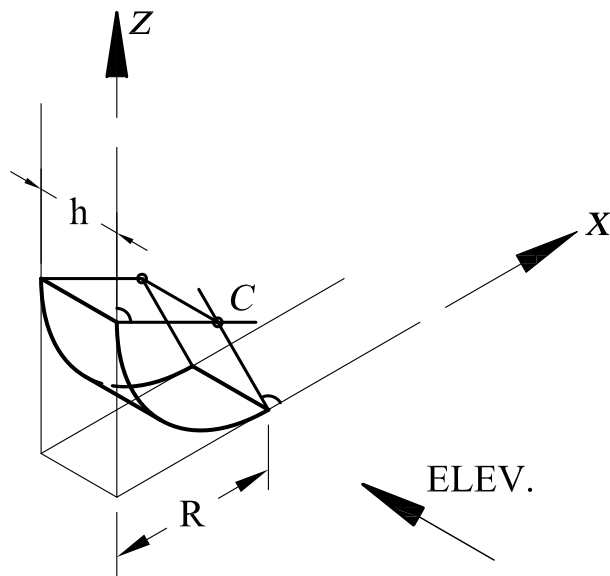
Construction of Isometric verical Cylinder



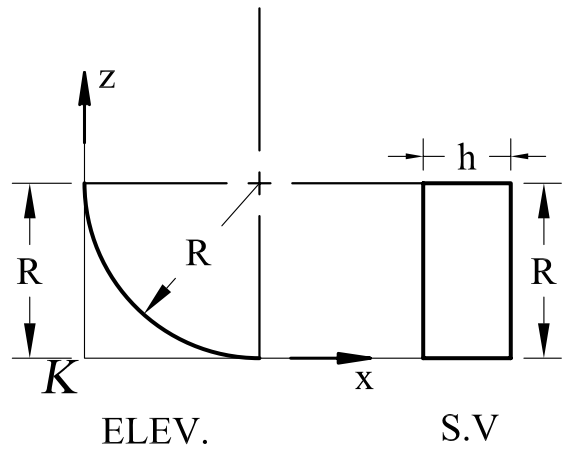
# ISOMETRIC ARC



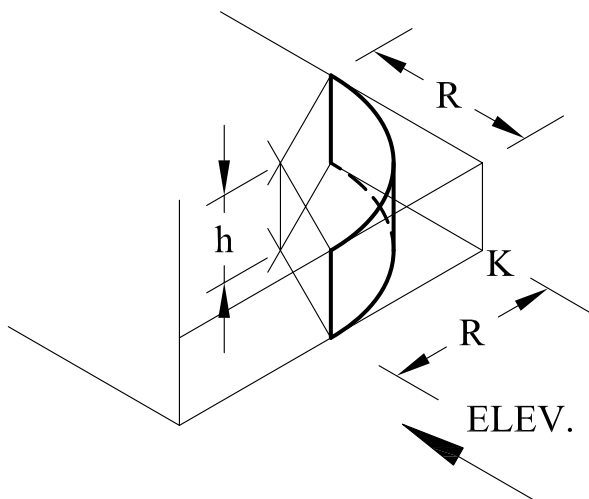
Construction of Isometric Arc



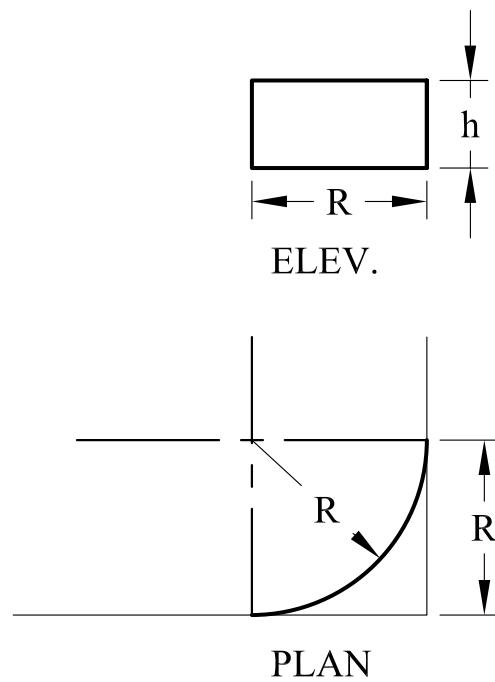
Isometric drawing of corner



Orthographic drawing of Corner

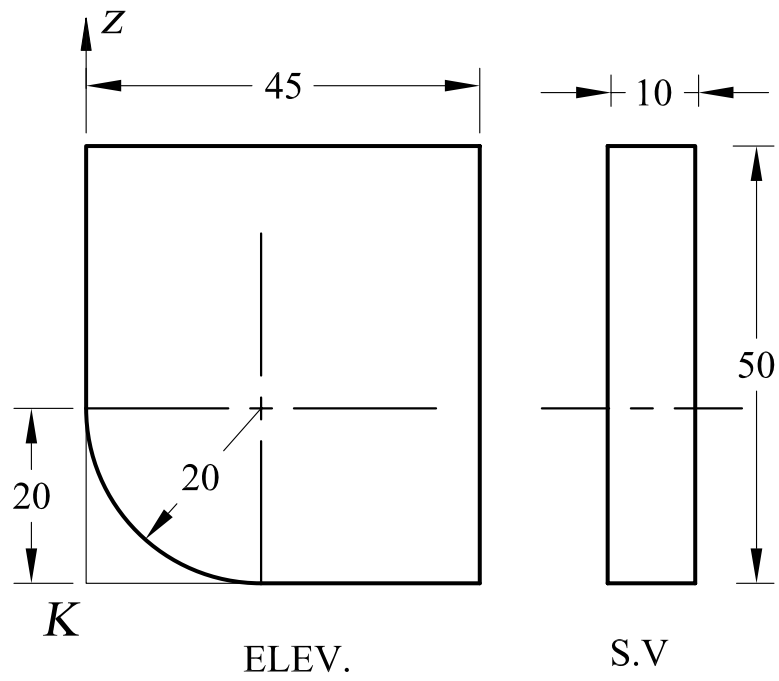


Isometric drawing of corner

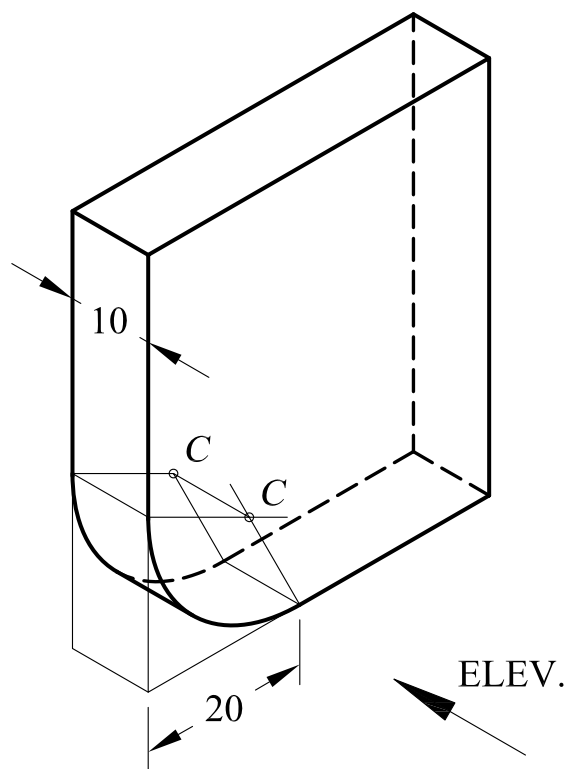


Orthographic drawing of Corner

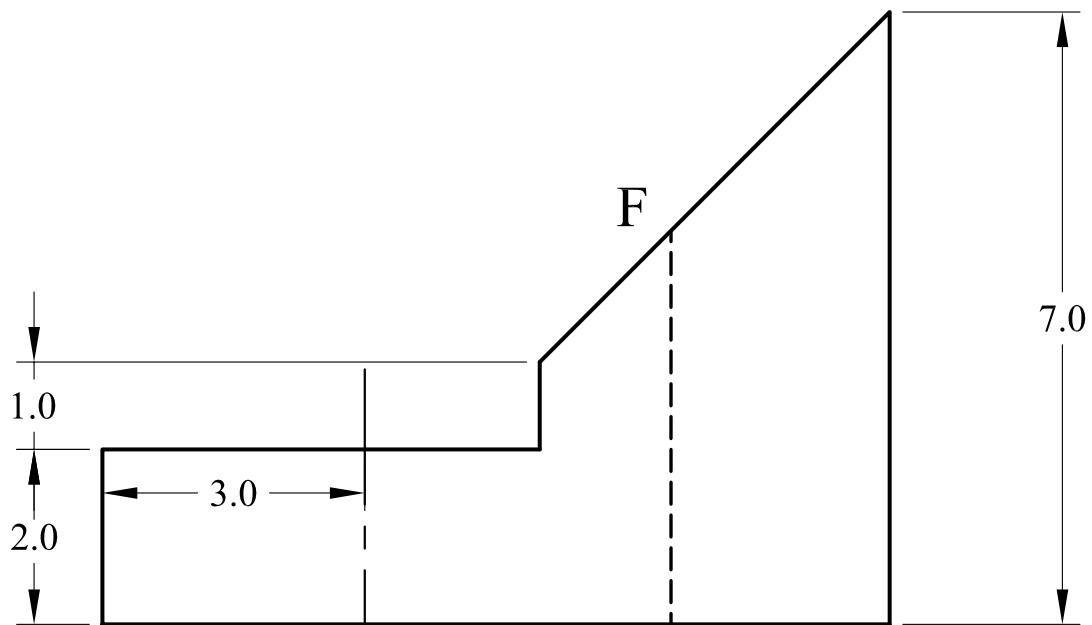
Drawing the thicknes of Isometric Corner



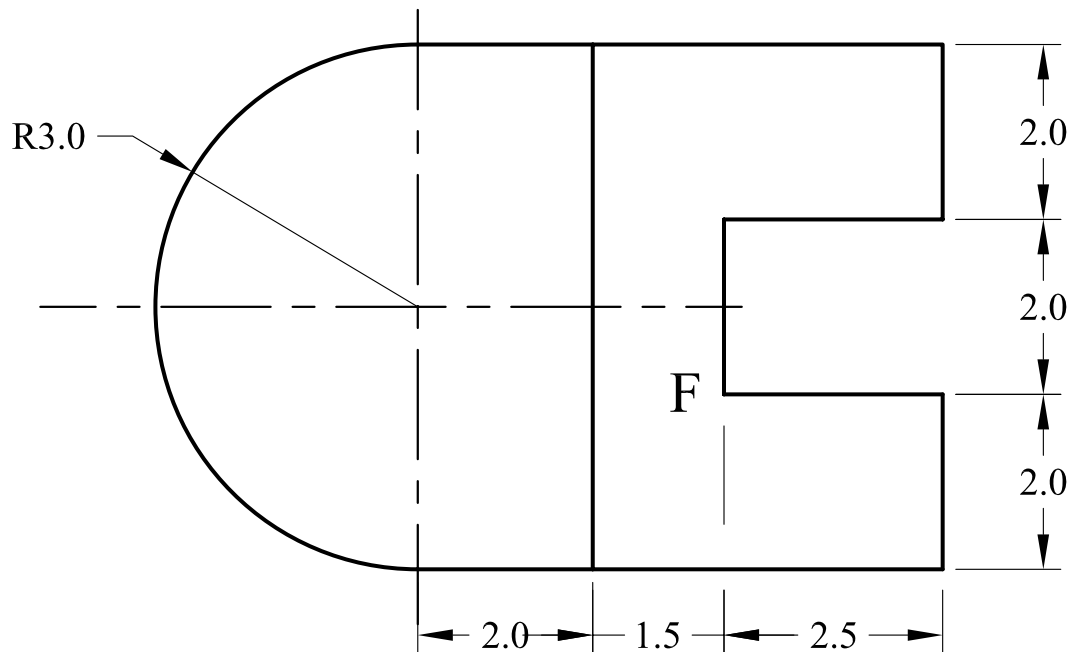
Orthographic drawing of Corner



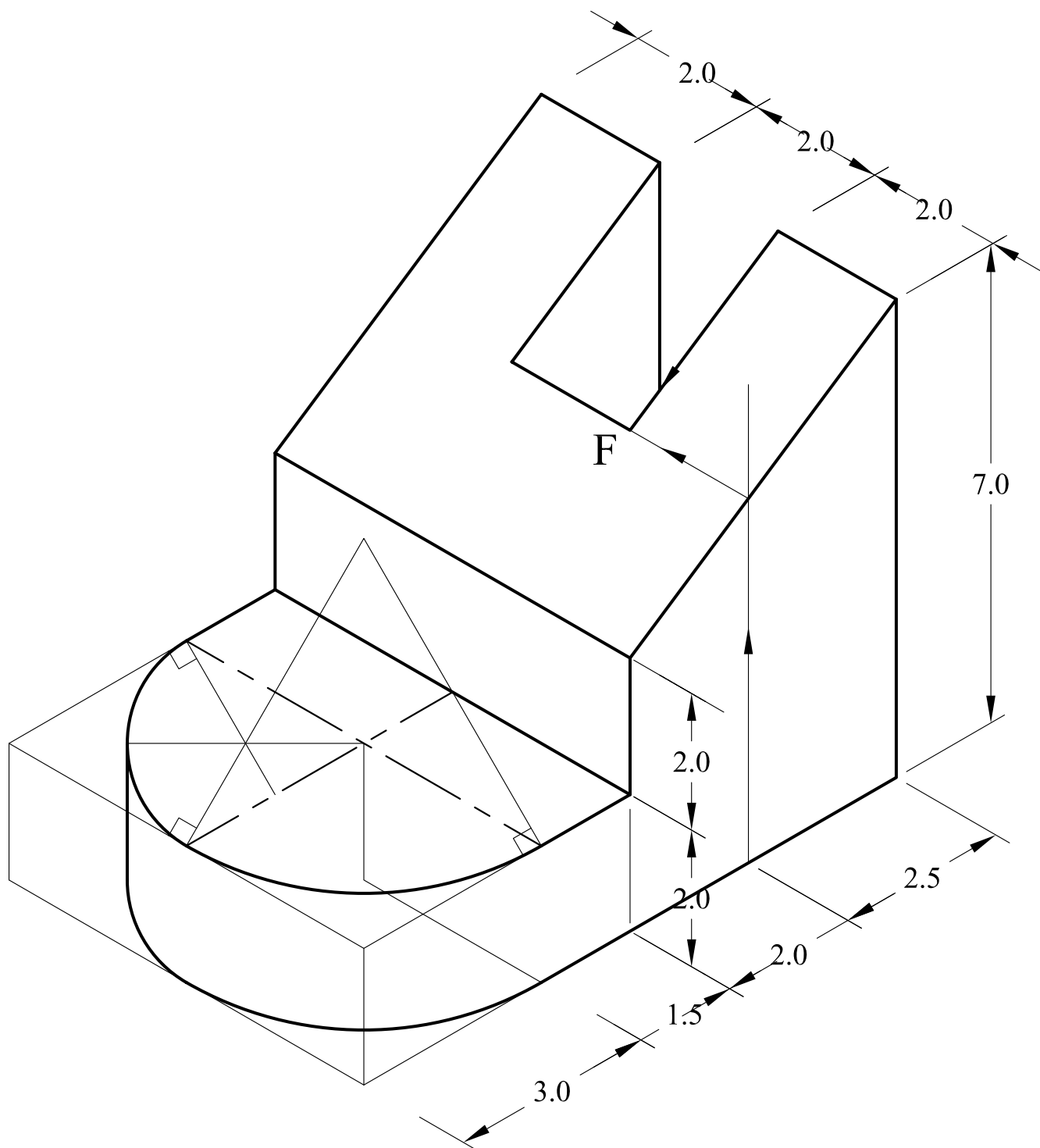
Construction of Isometric Arc on the corners

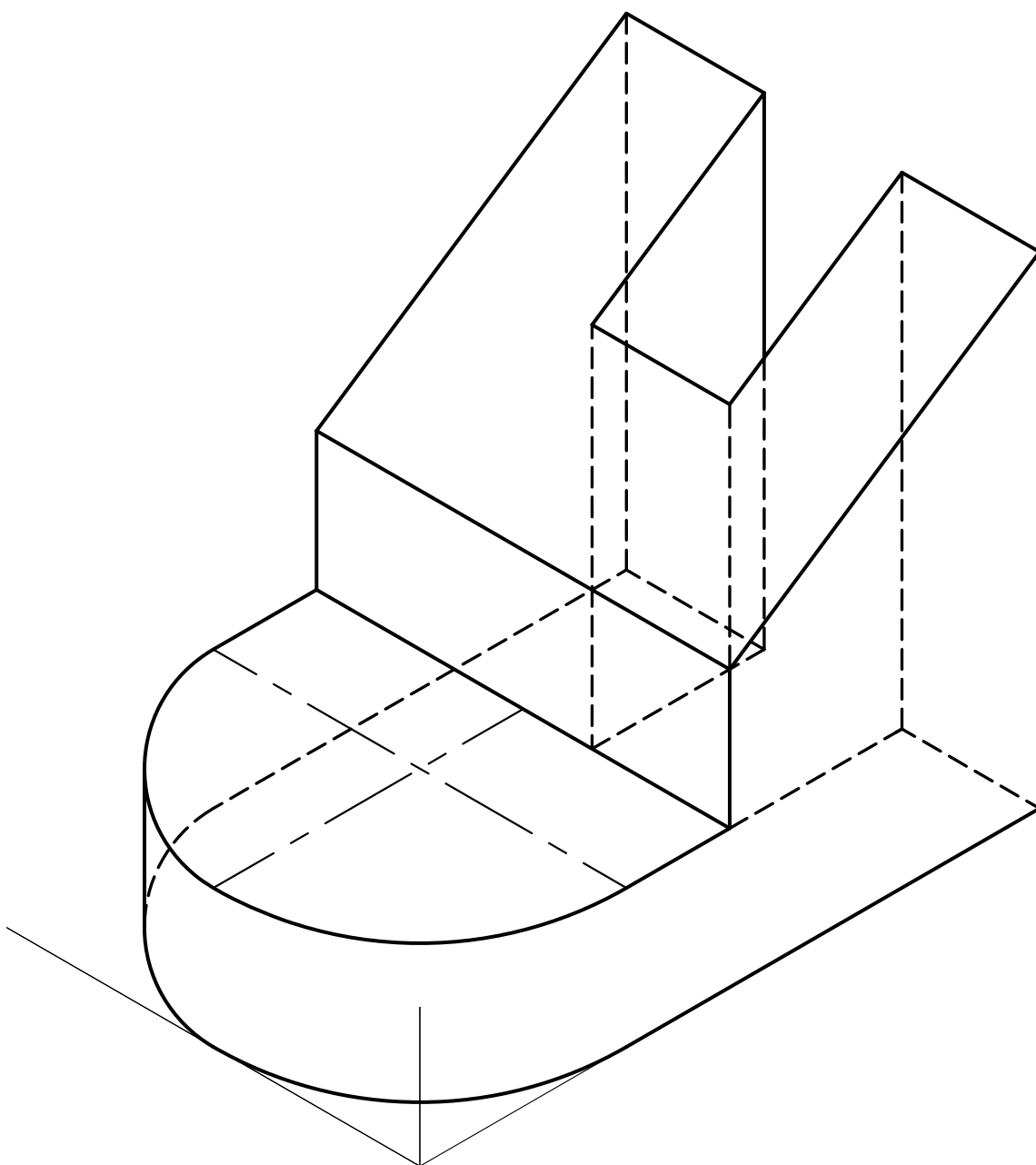


ELEV.



PLAN

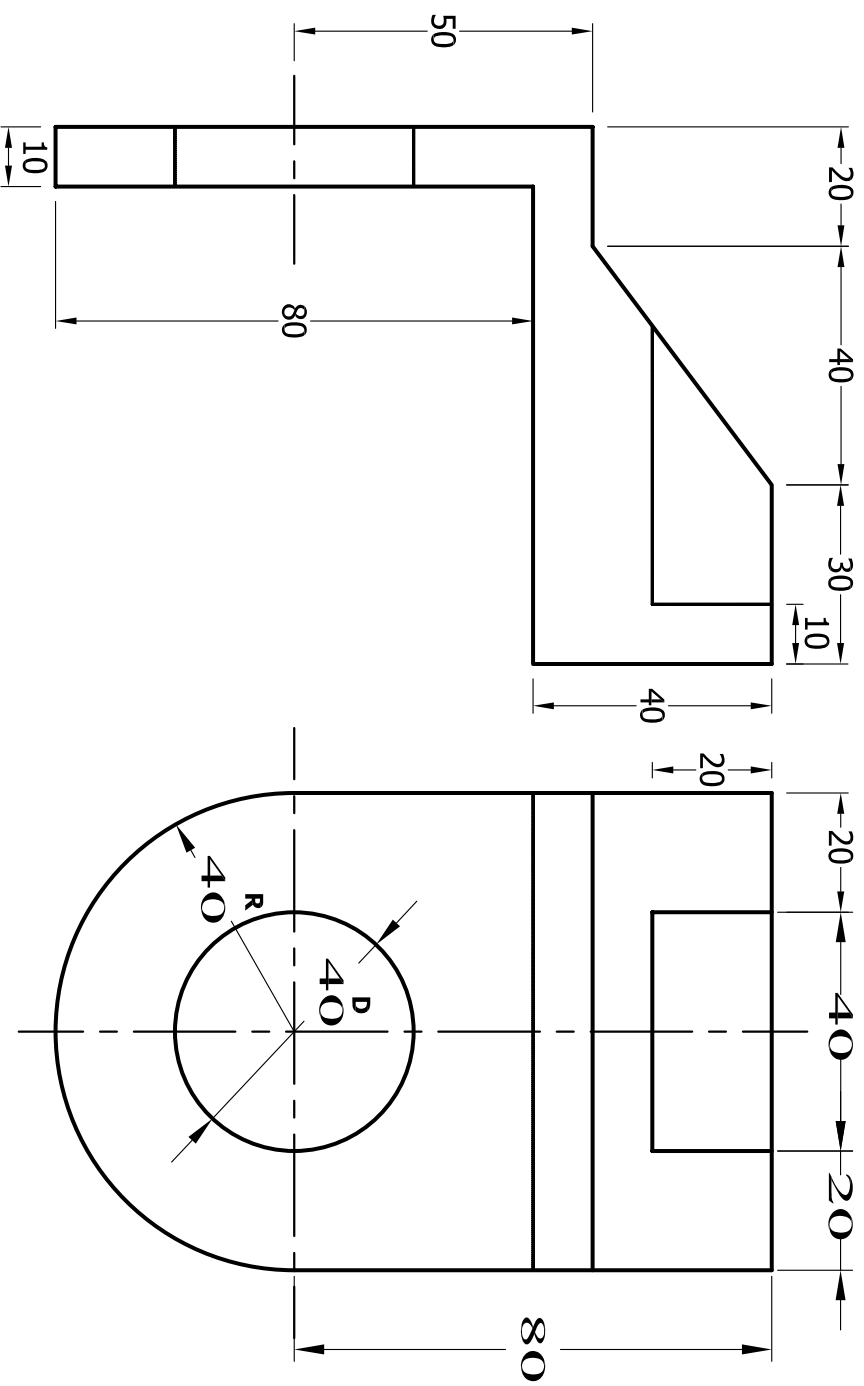




FOR THE GIVEN BODY, DRAW THE ISOMETRIC .

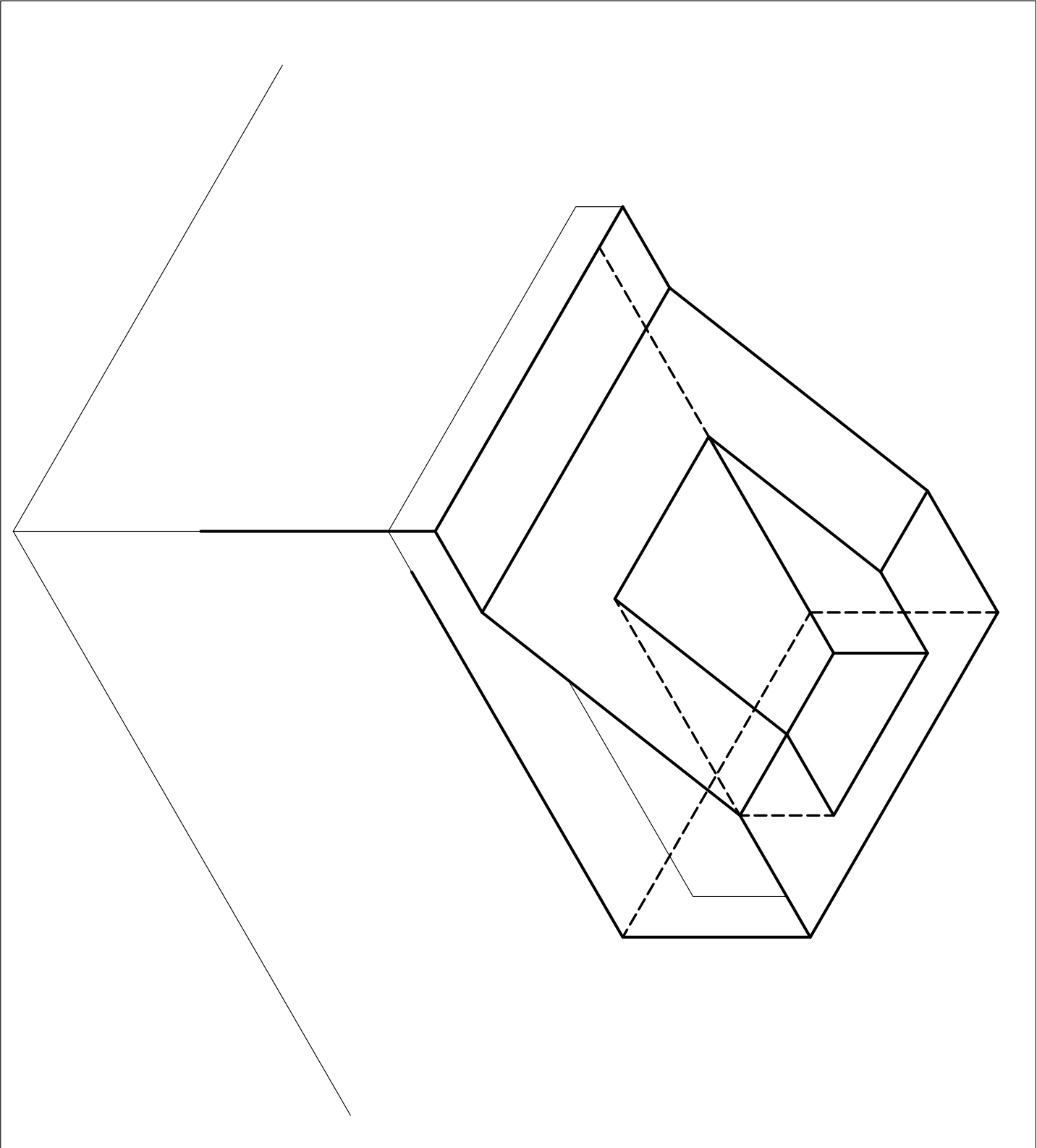
DIM. IN MM.

SCALE 1:1

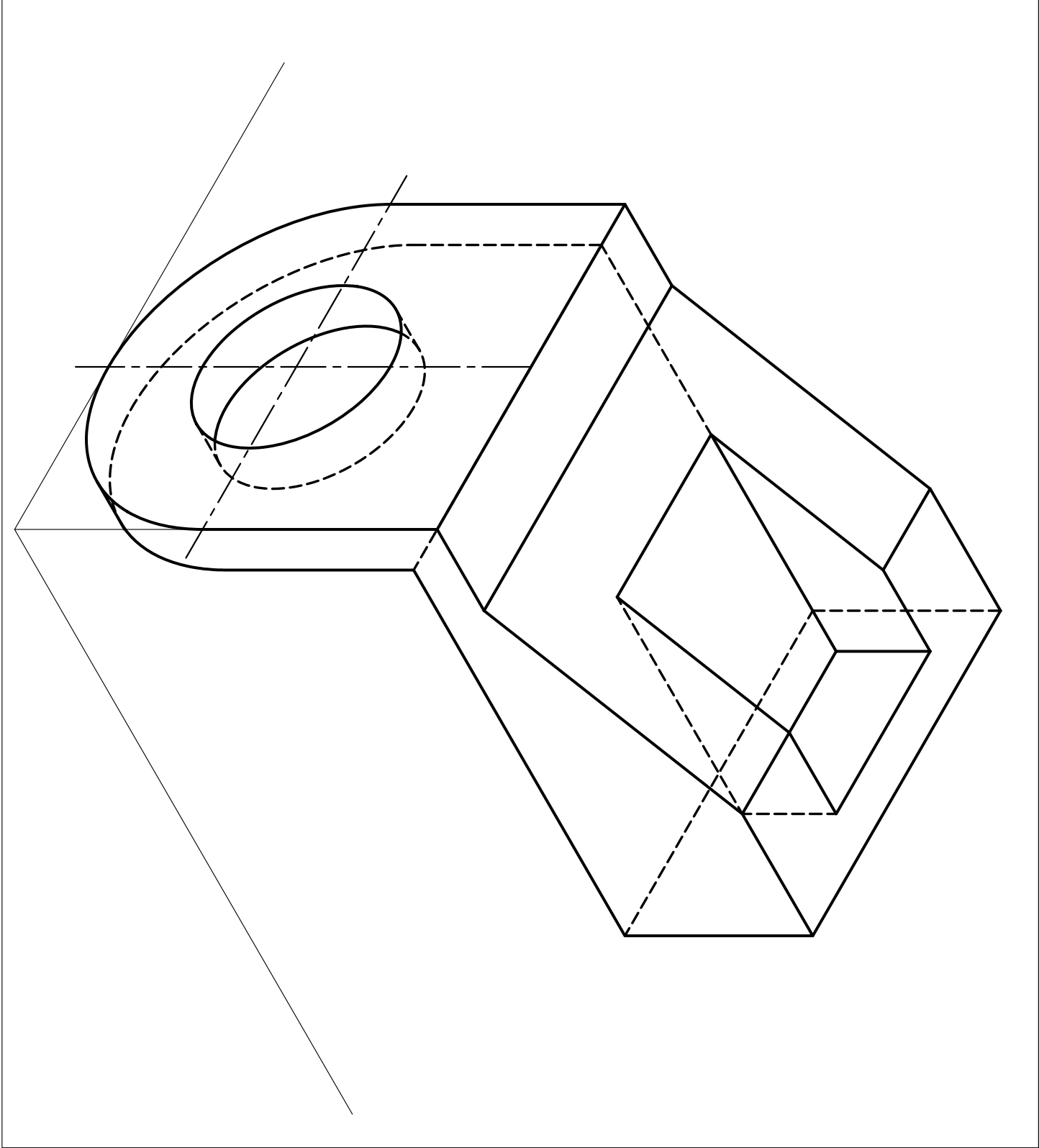


ELEVATION

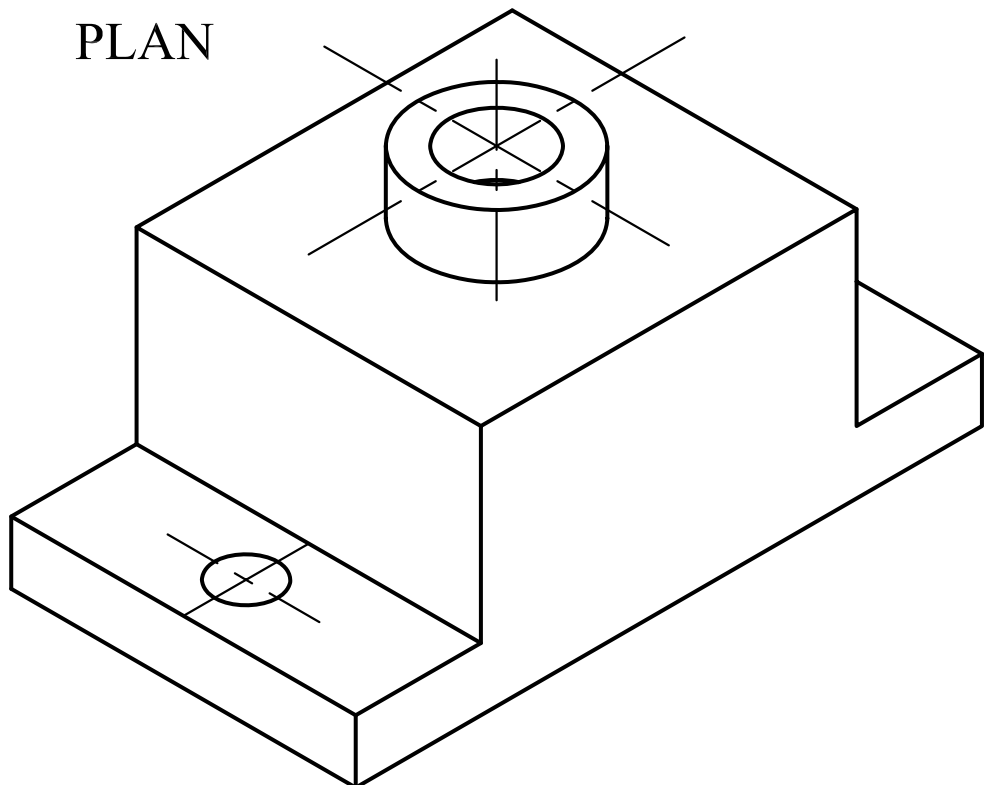
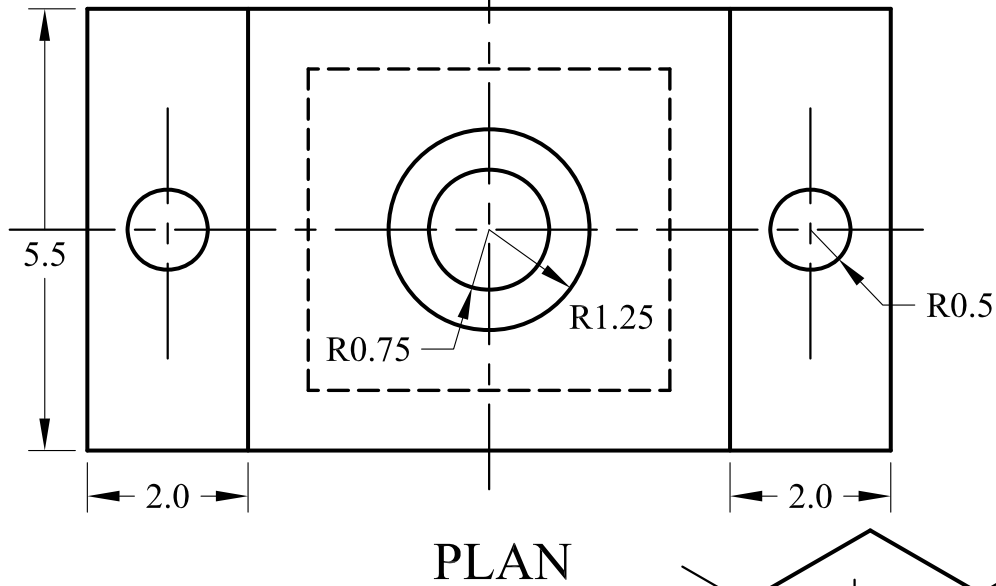
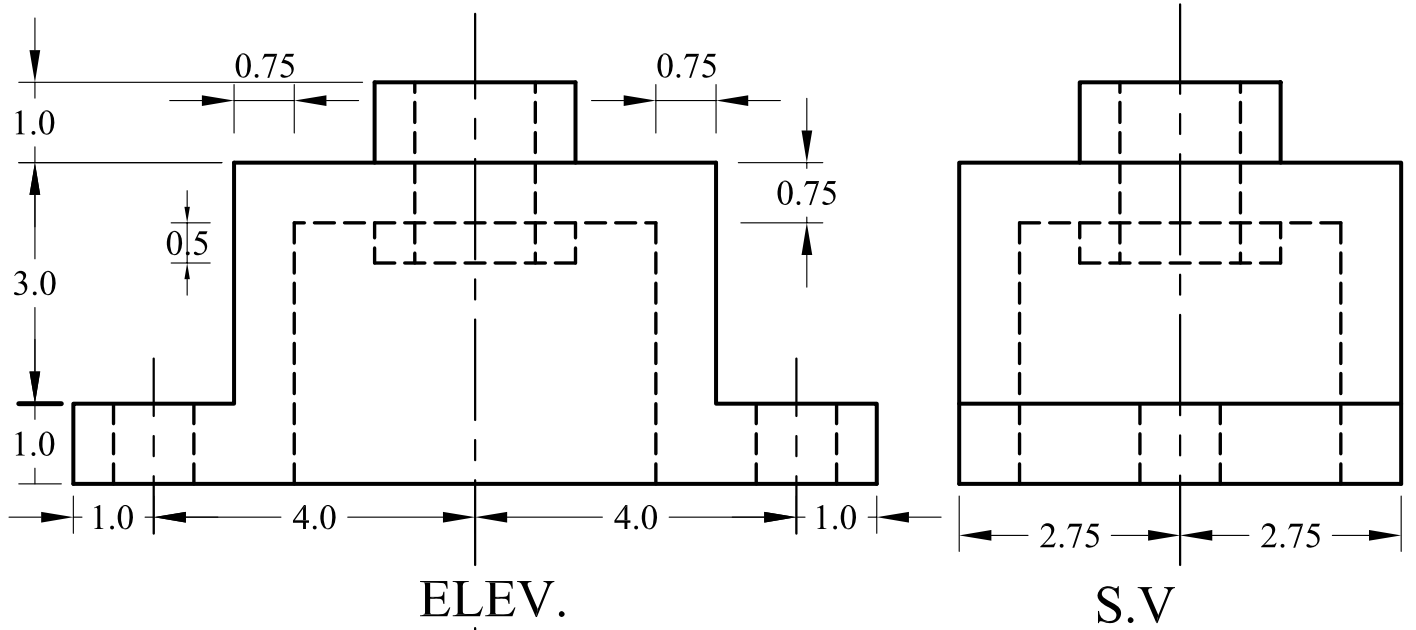
SIDE VIEW



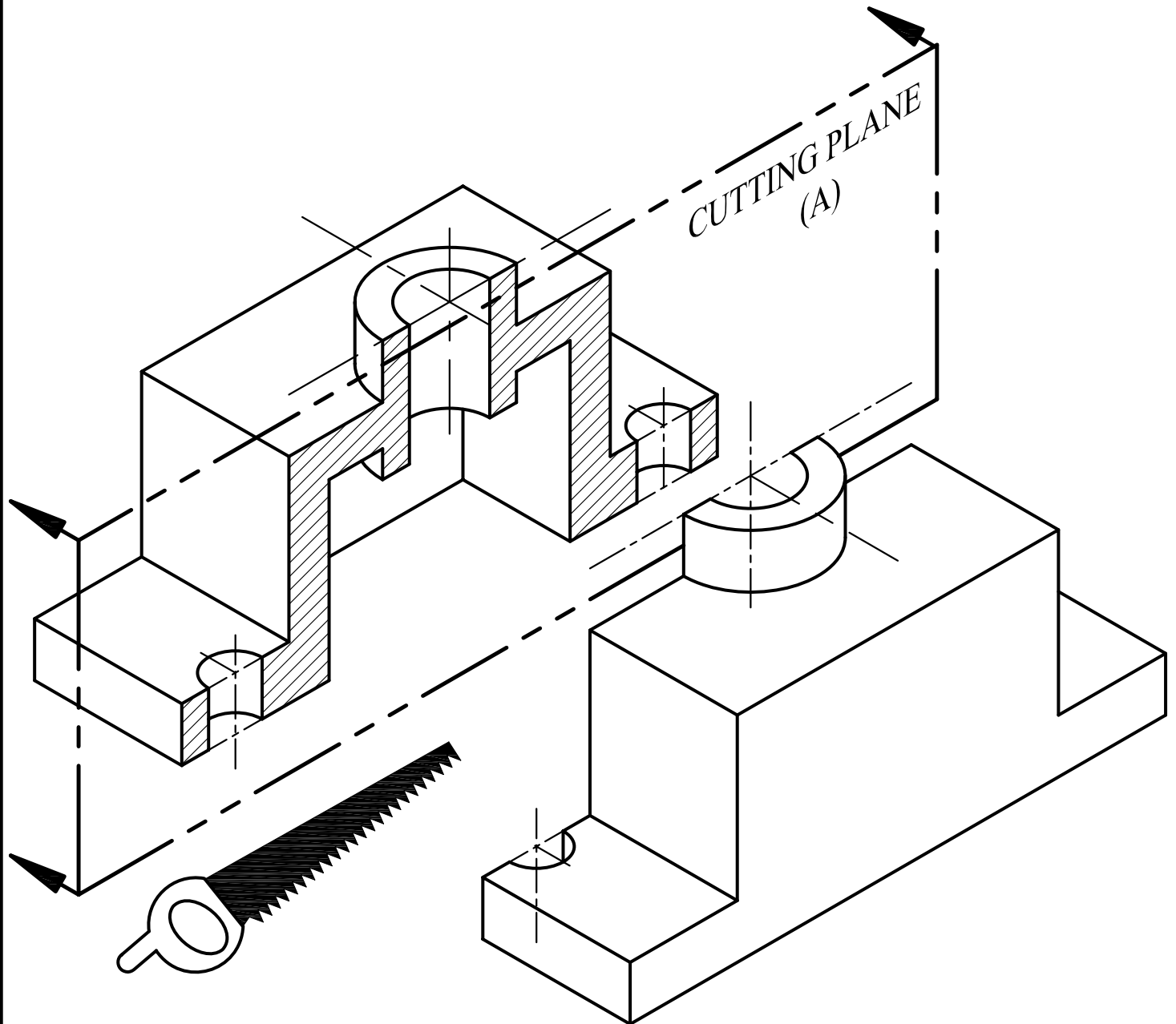




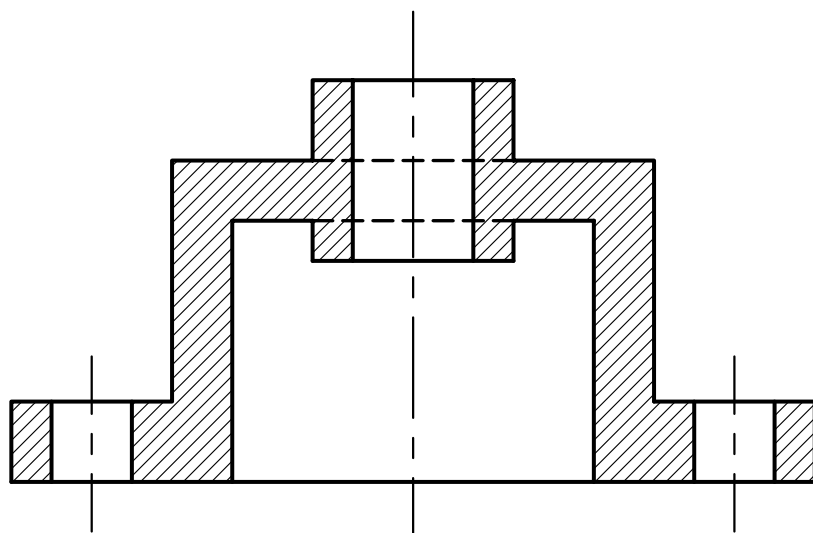
# SECTIONS



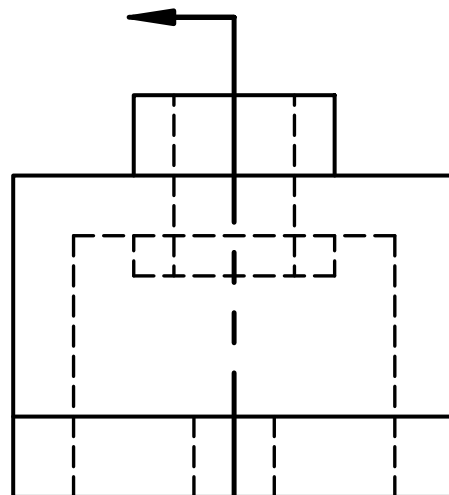
# FULL SECTIONS



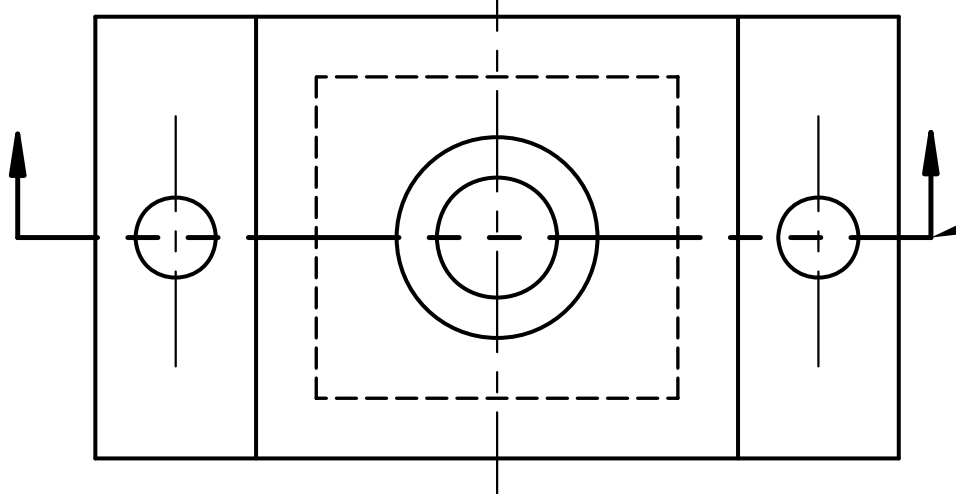
SECTION ELEVATION



SEC. ELEV.

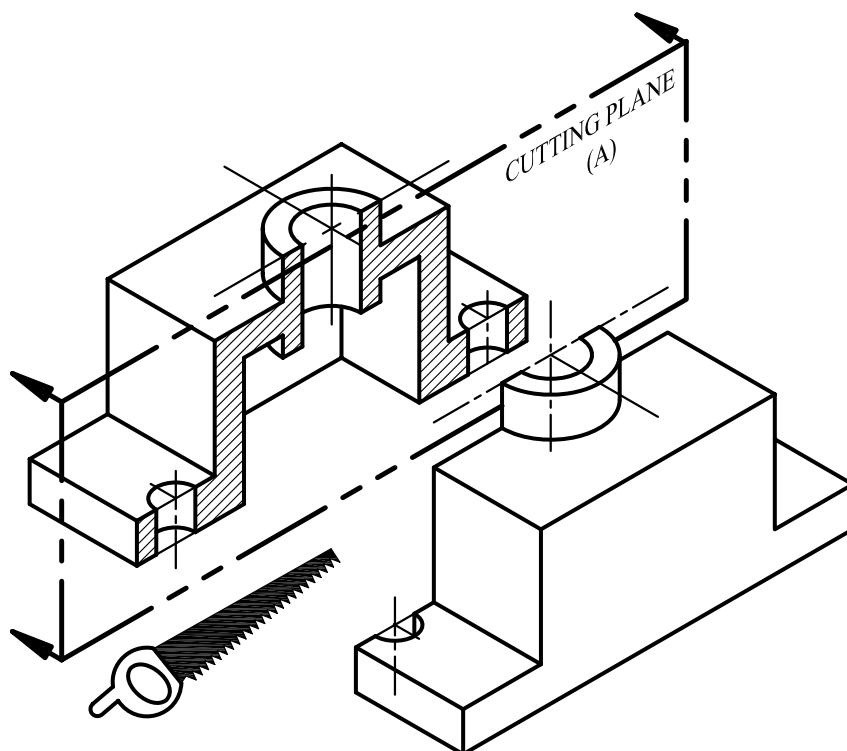


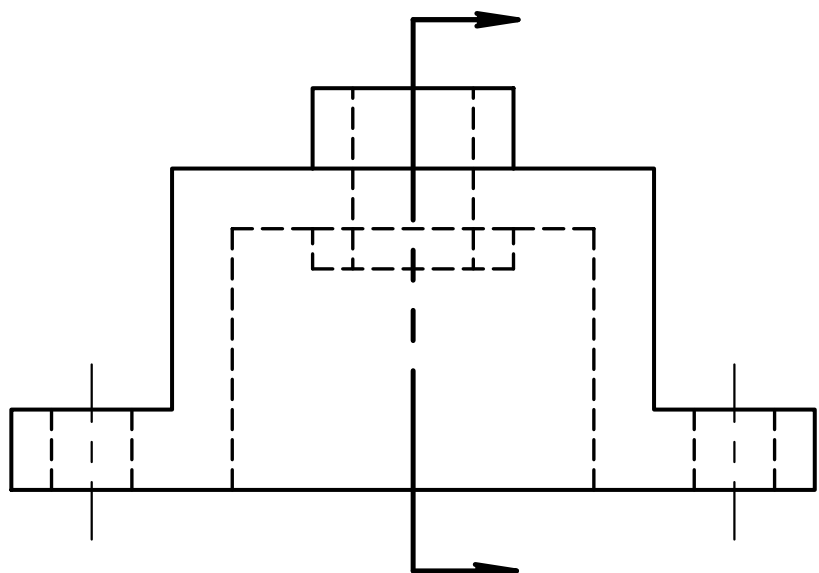
S.V



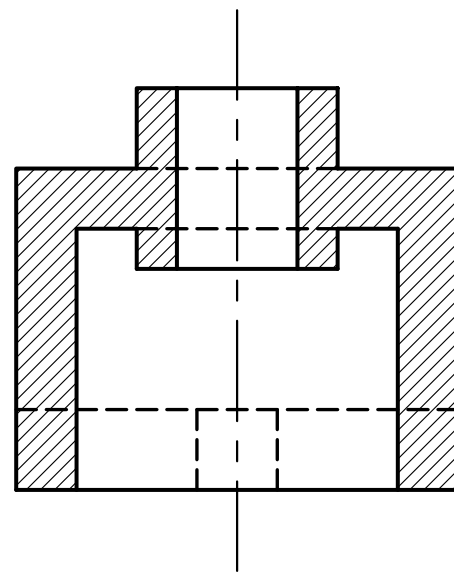
PLAN

CUTTING  
PLANE (A)



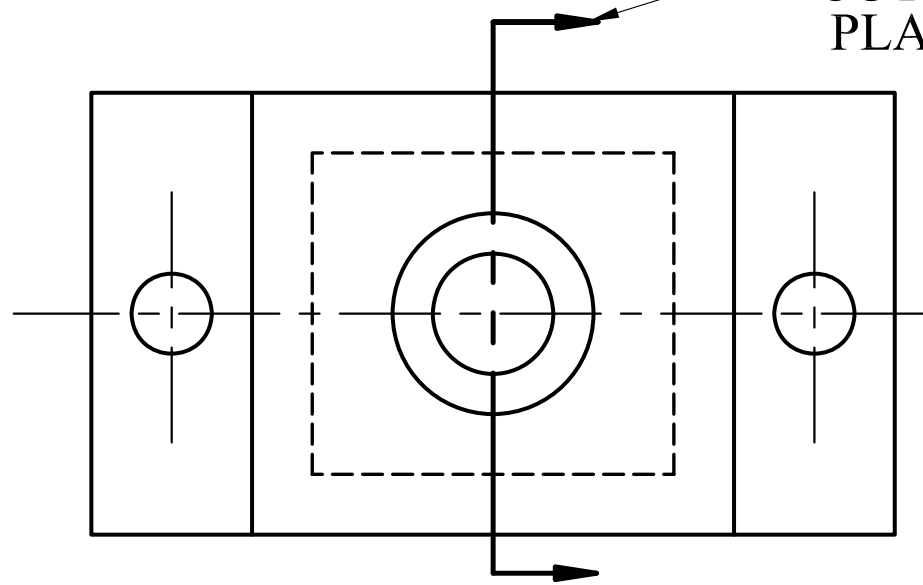


ELEV.

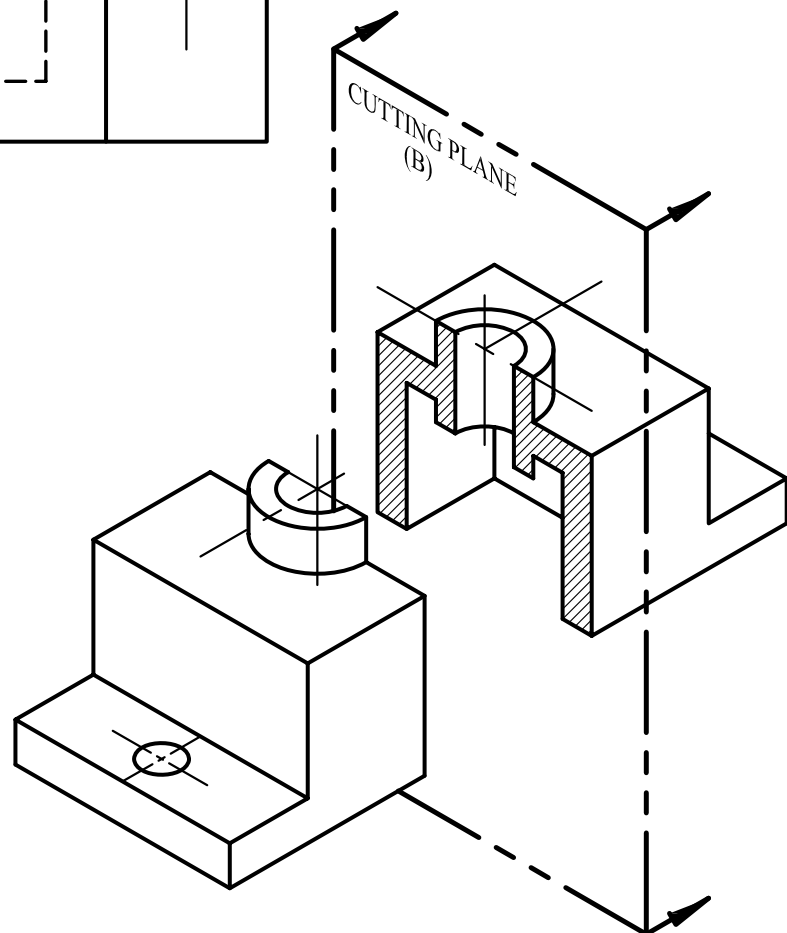


SEC. S.V

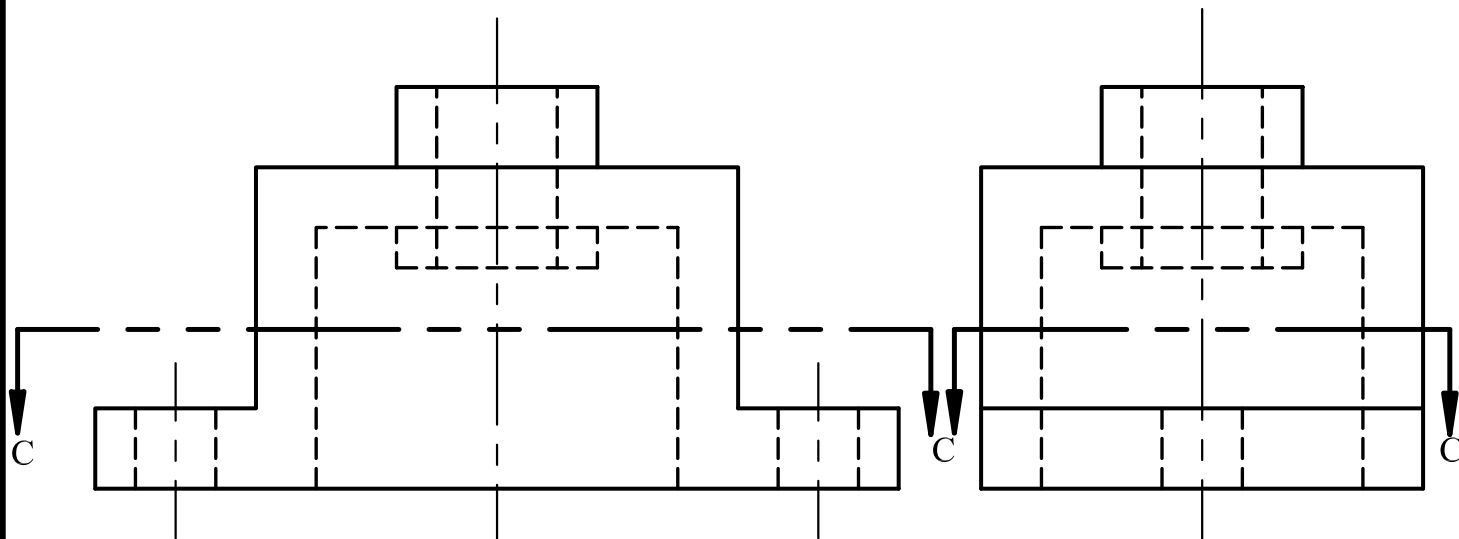
CUTTING  
PLANE (B)



PLAN

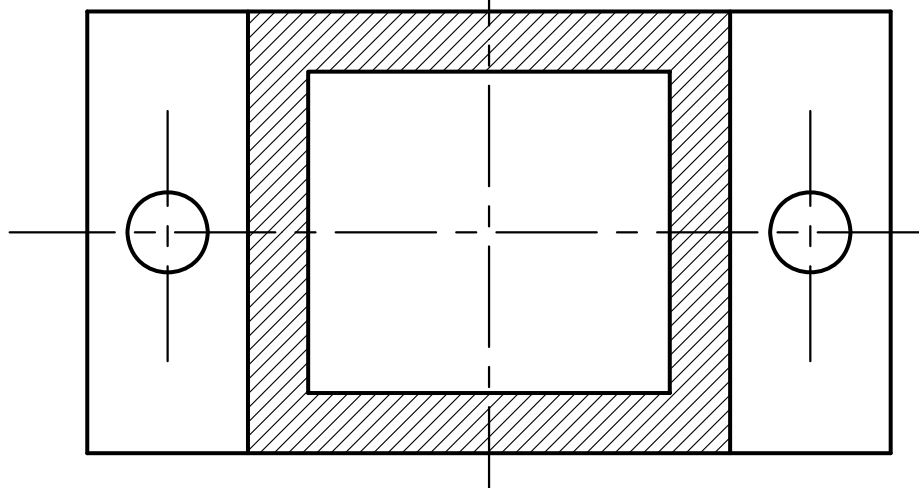


SECTION SIDE VIEW

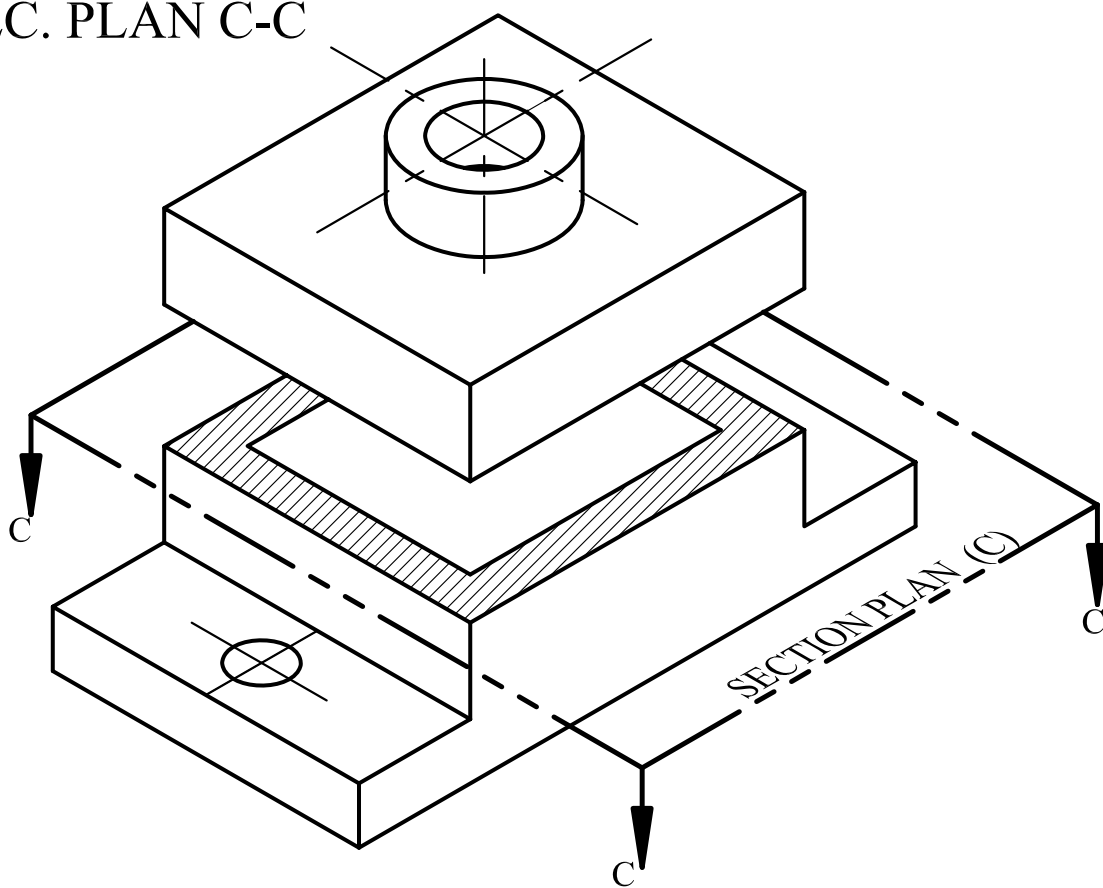


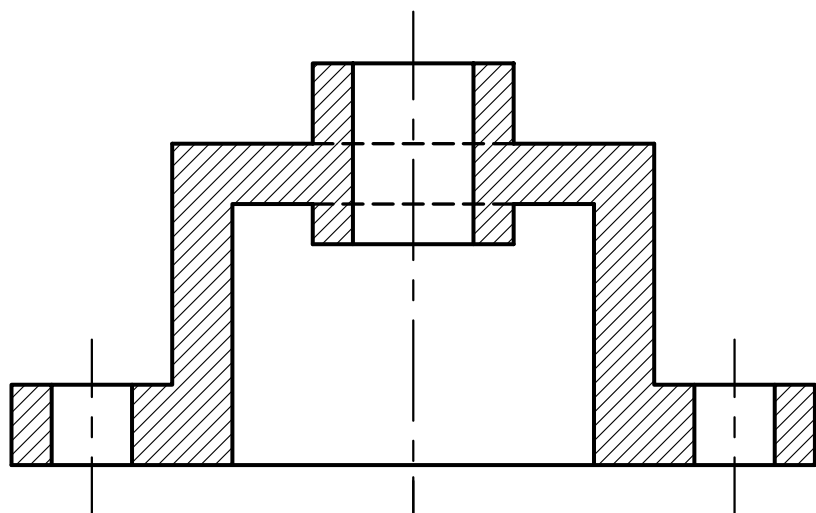
ELEV.

S. V.

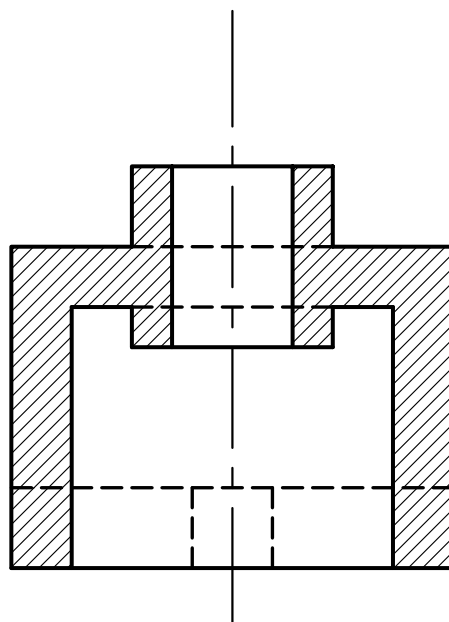


SEC. PLAN C-C

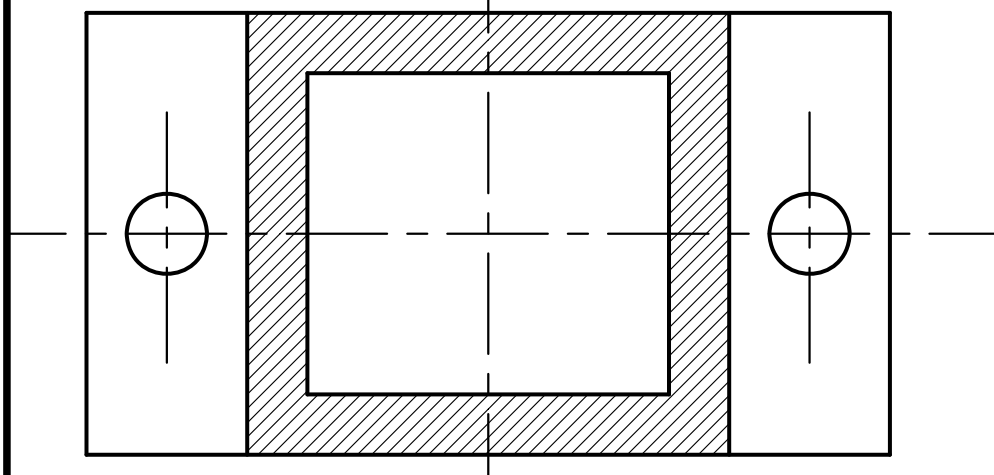




SEC. ELEV.

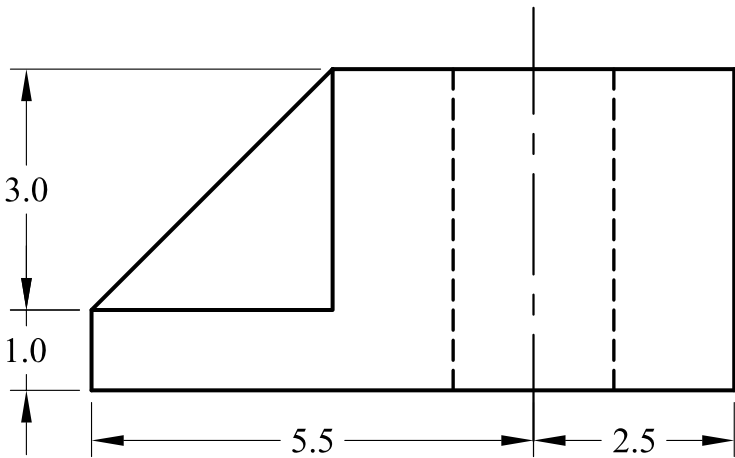
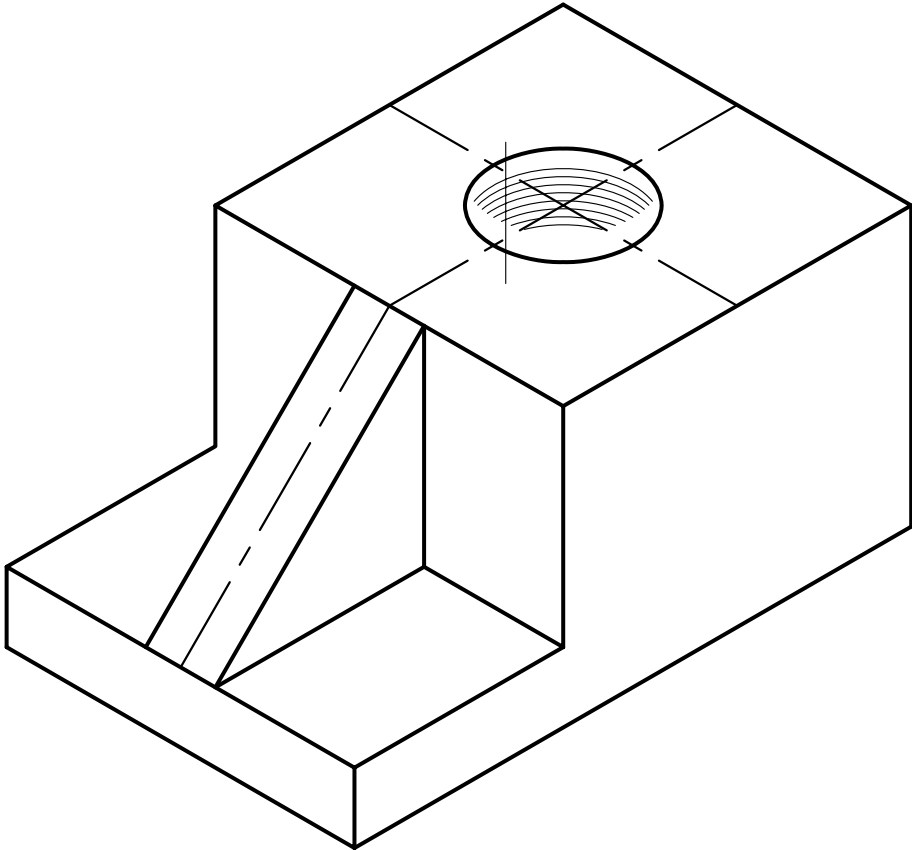


SEC. S.V.

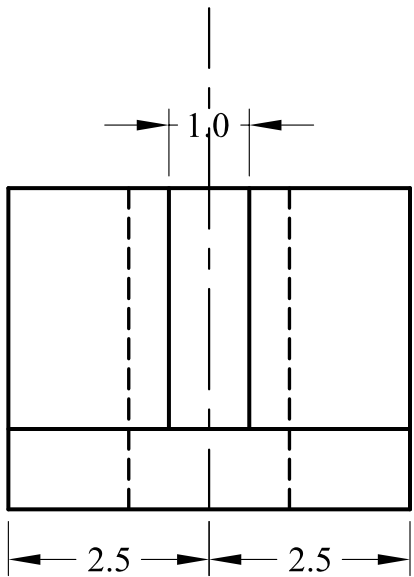


SEC. PLAN C-C

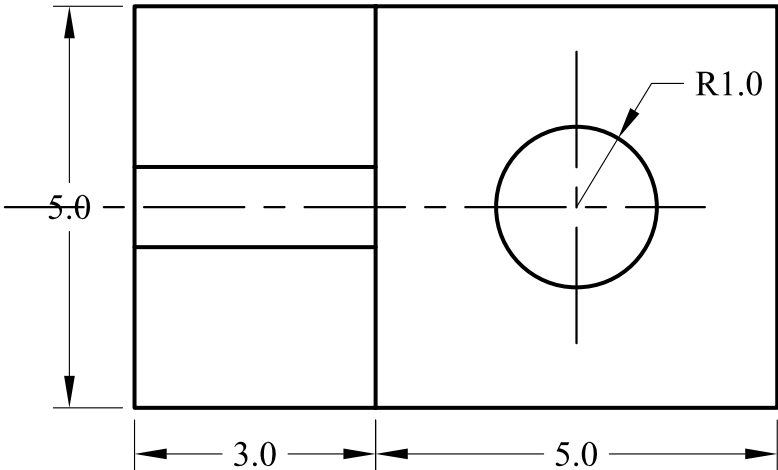
# SECTIONS IN WEBS



ELEV.

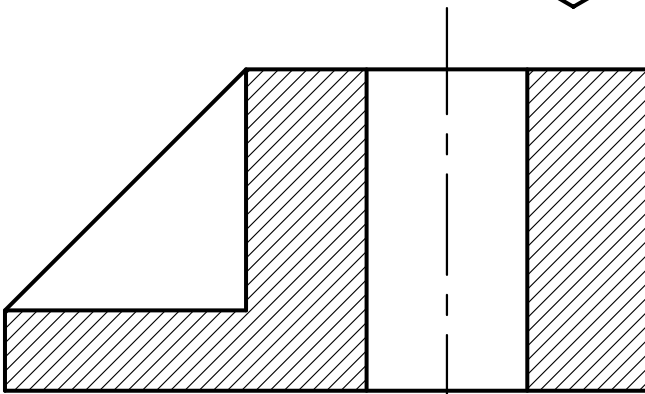
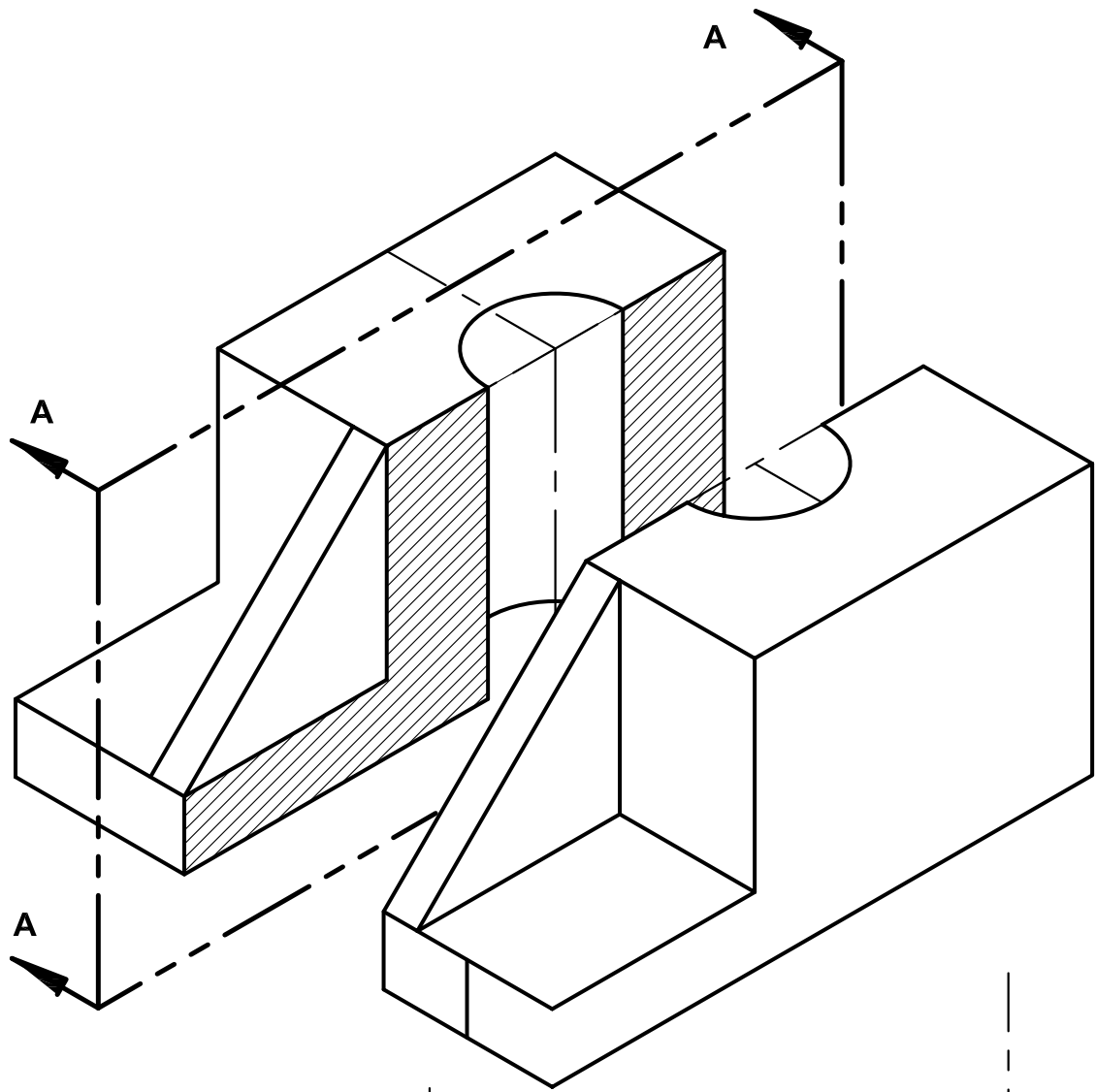


S.V.

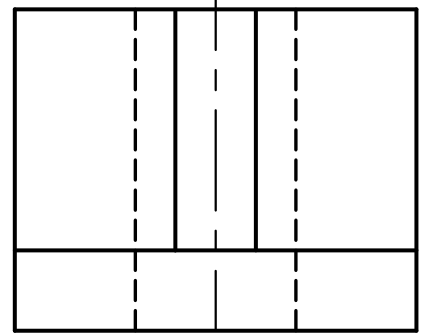


PLAN

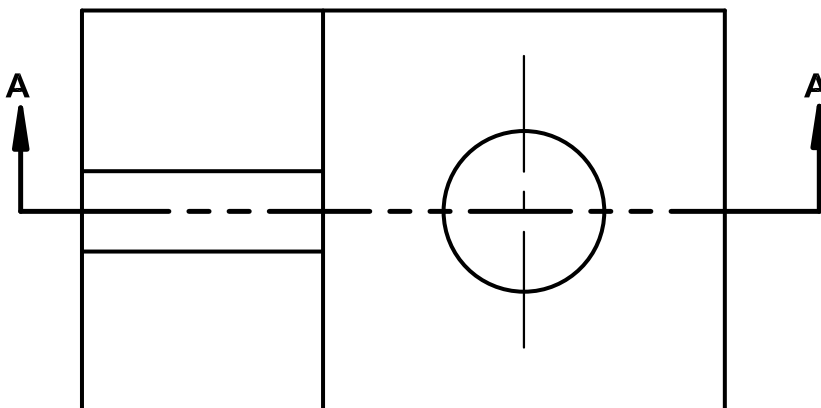




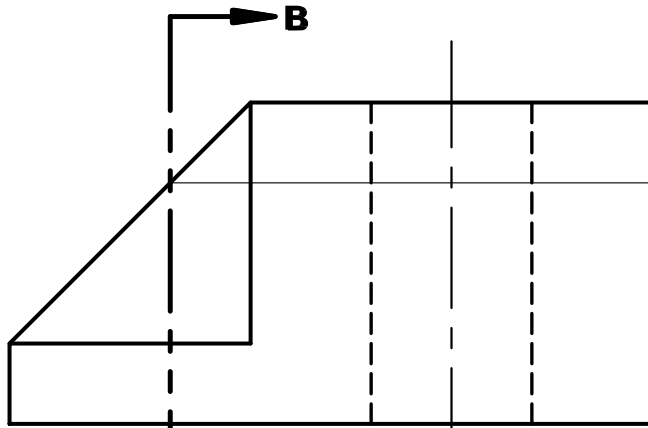
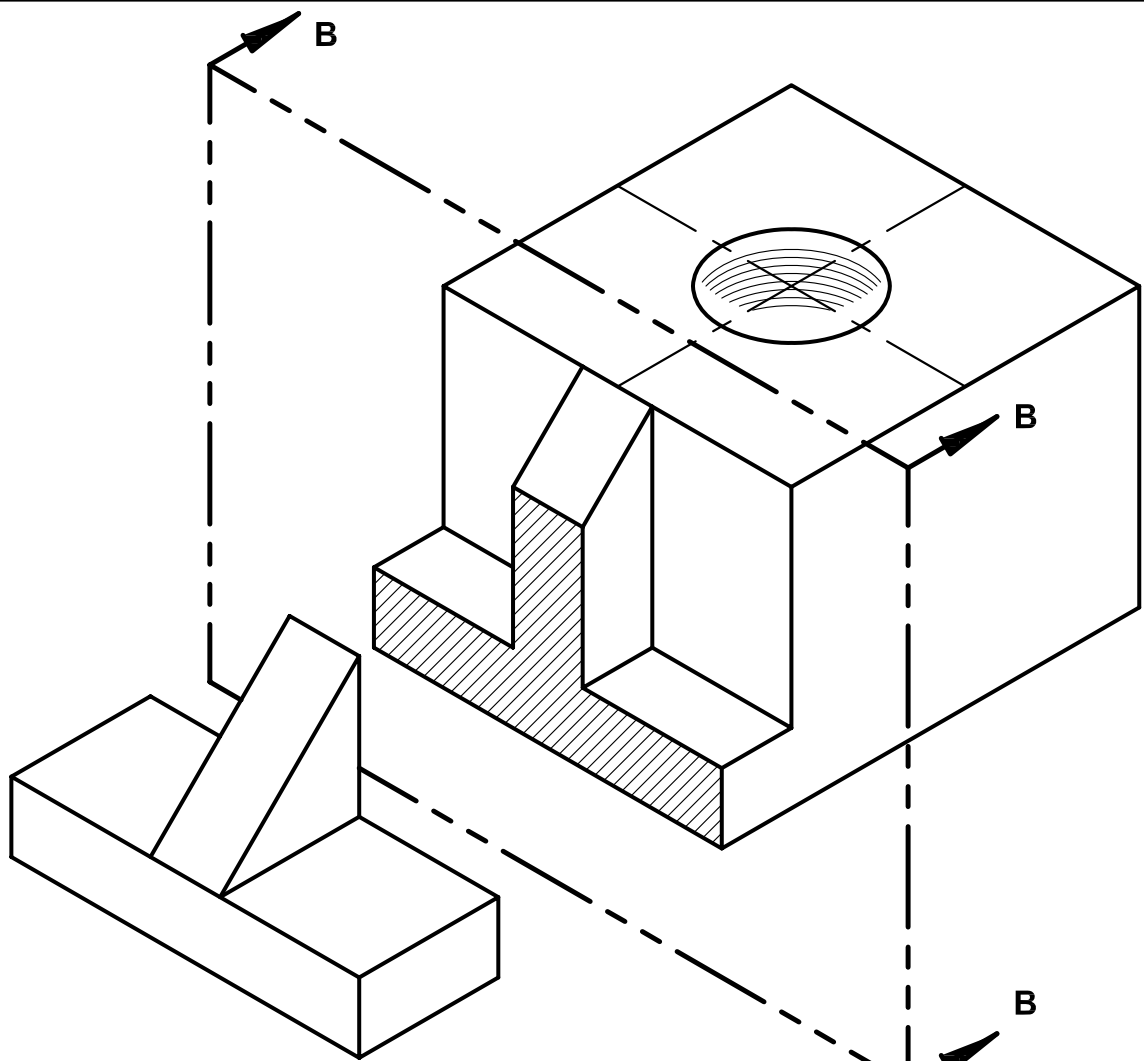
SEC. ELEV. A- A



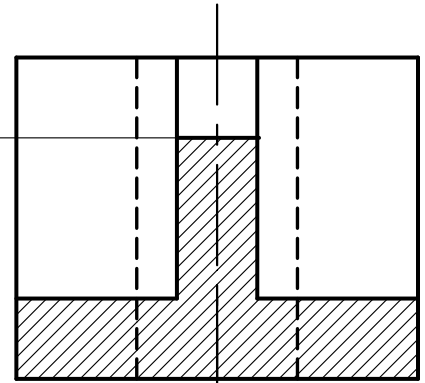
S.V.



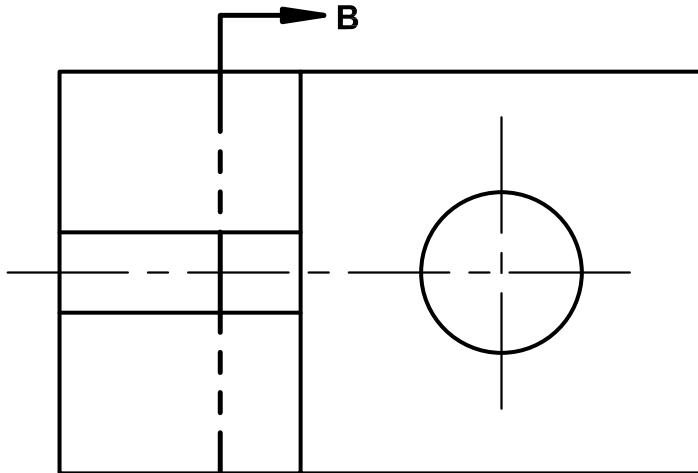
PLAN



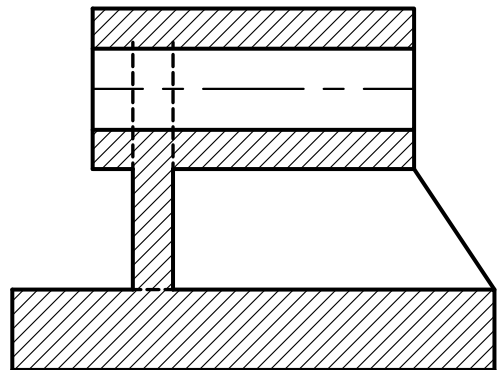
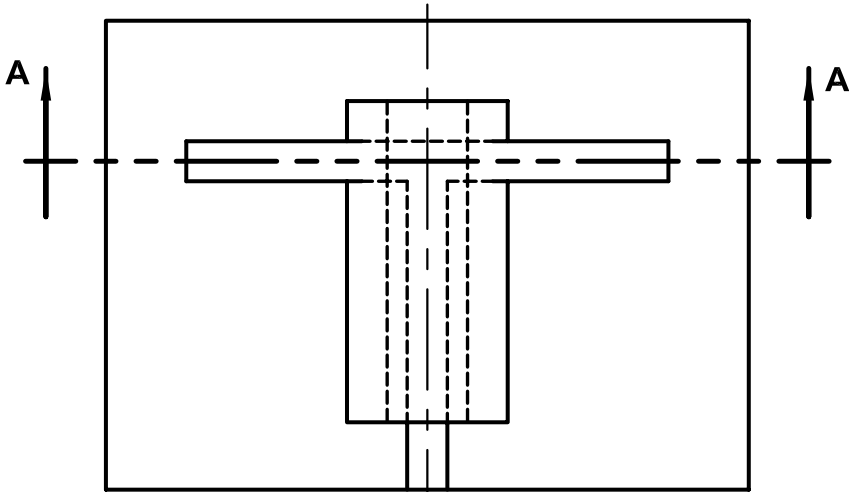
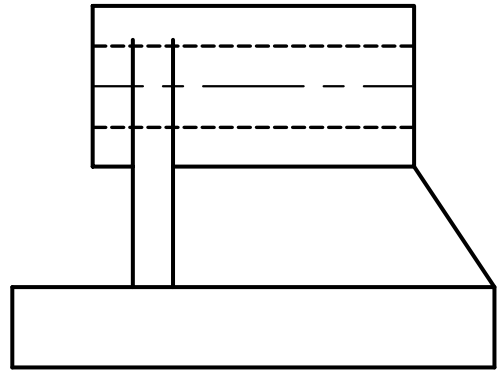
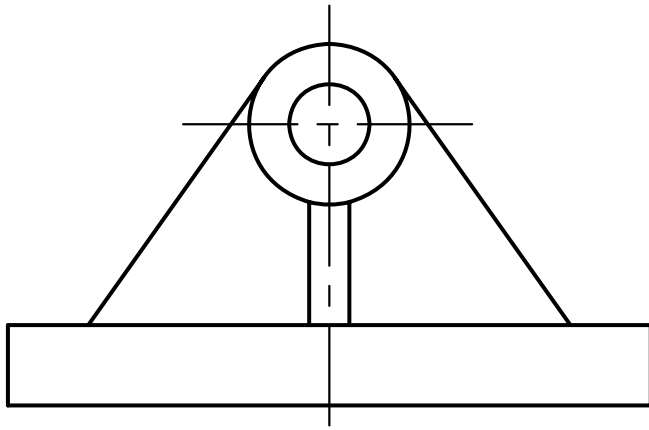
ELEV.



SEC. S.V. B- B

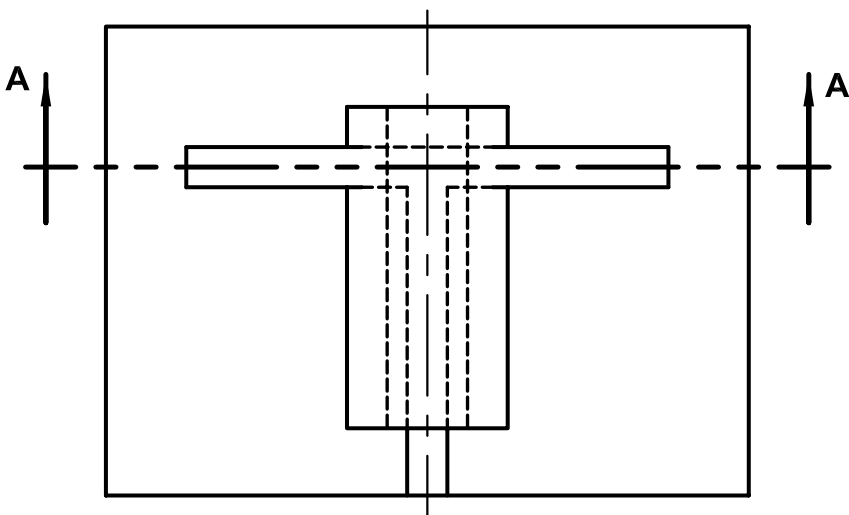


PLAN

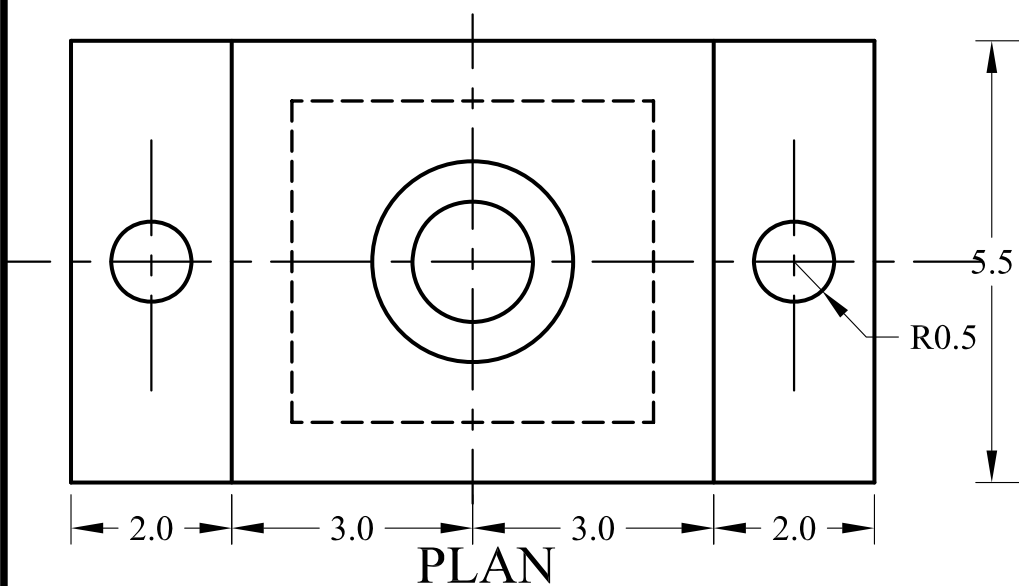
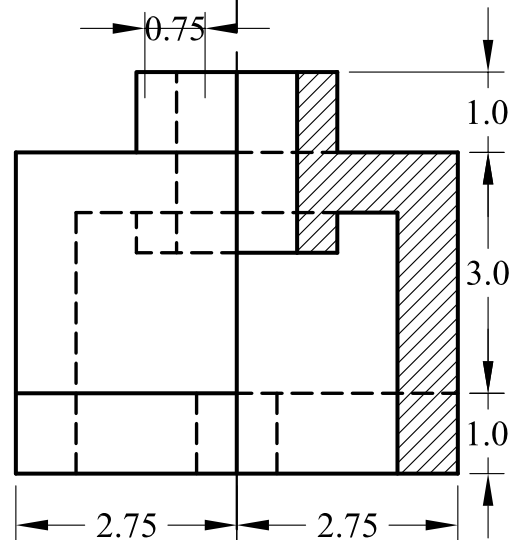
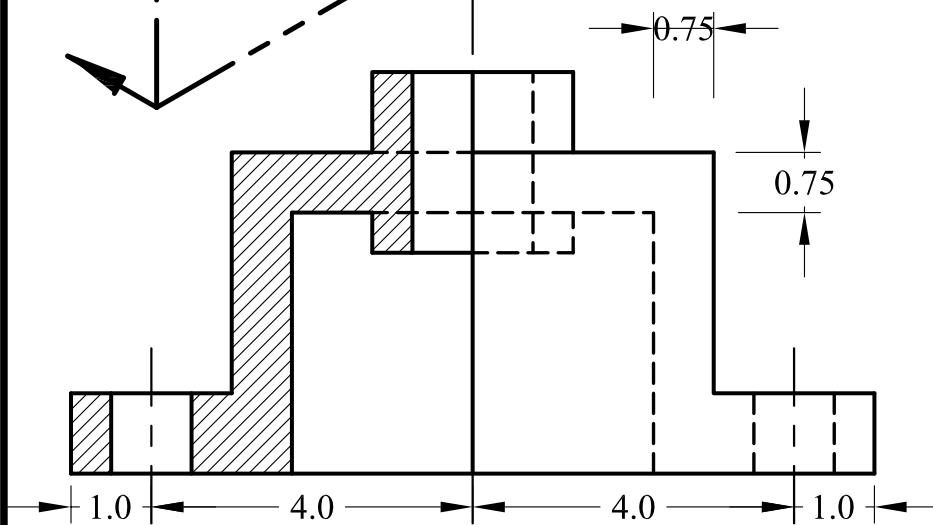
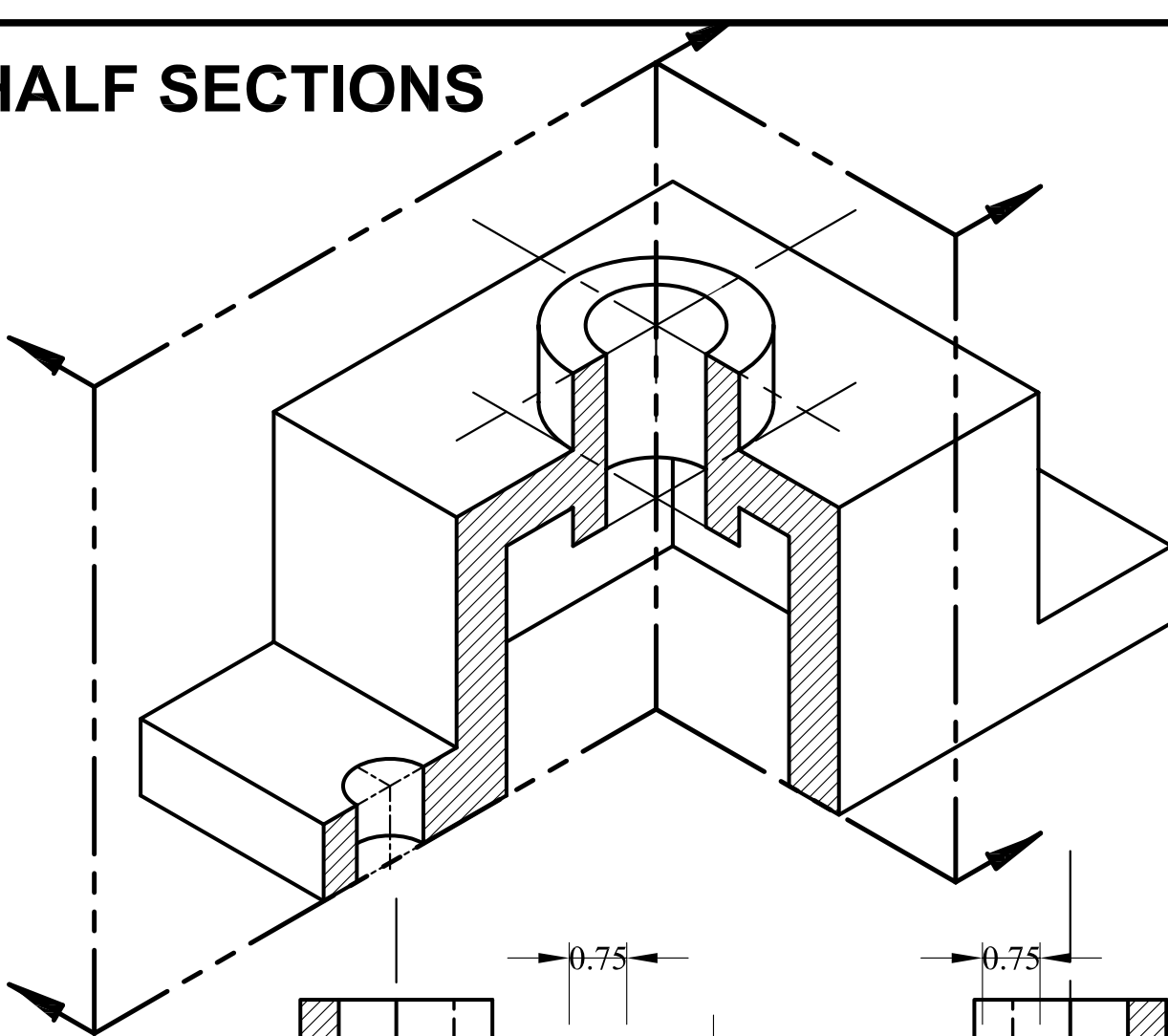


SEC. ELEV. A- A

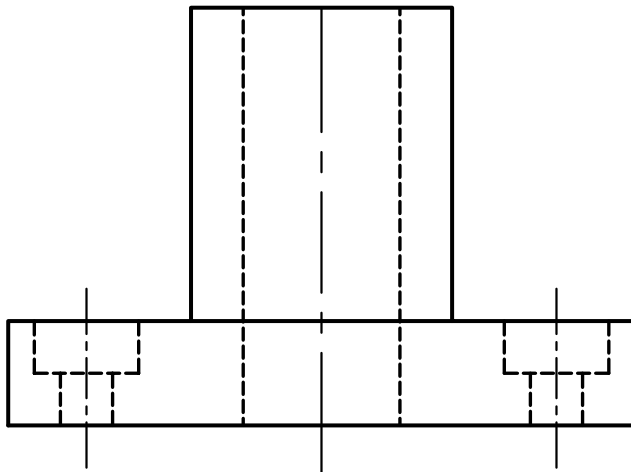
SEC. S. V.



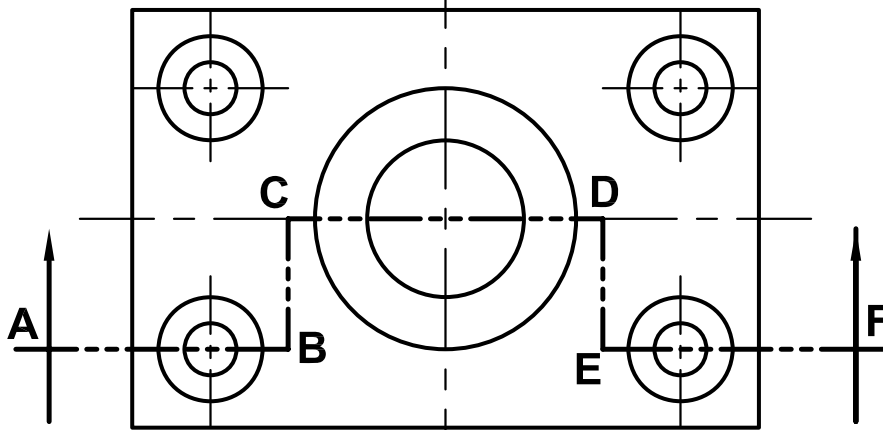
# HALF SECTIONS



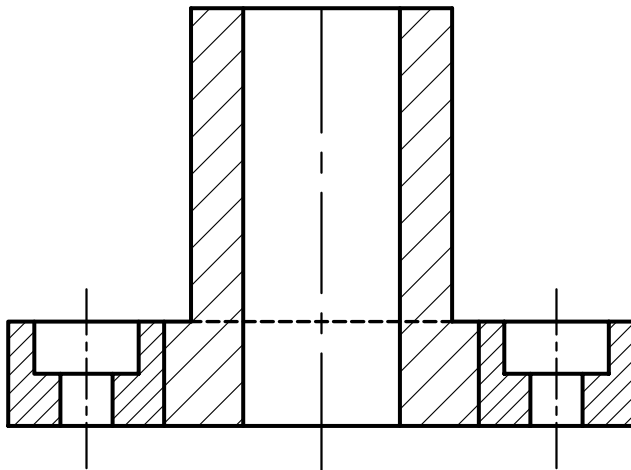
# OFFSET SECTION



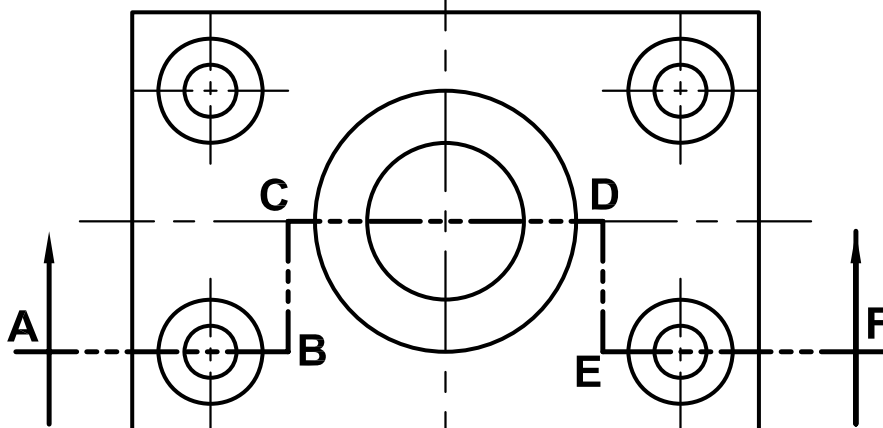
ELEV.



PLAN



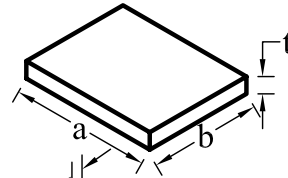
SEC. ELEV. A-B-C-D-E-F



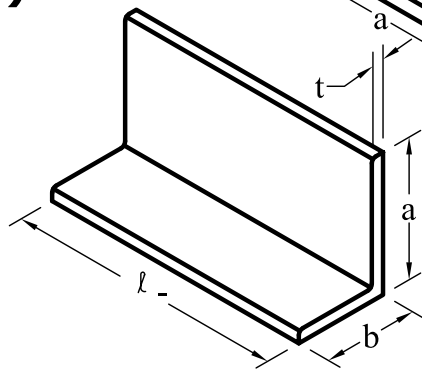
PLAN

# PROJECTION OF STEEL CONSTRUCTION

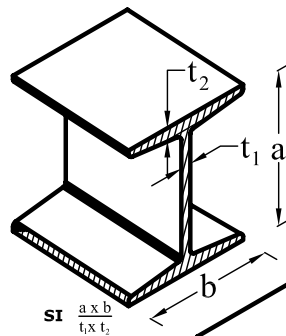
## 1- PLATES ( PL )



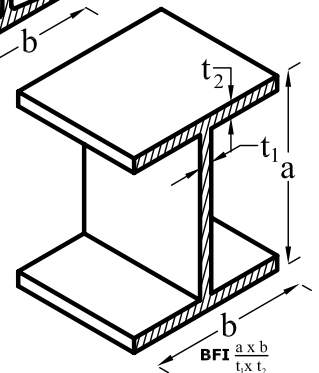
## 2- ANGLES ( L )



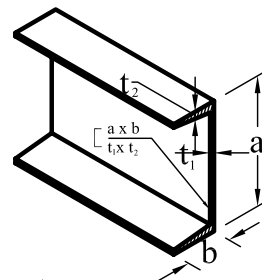
## 3- STANDARD I. SECTION ( SI )



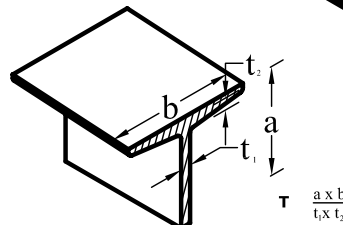
## 4- BROAD FLANG I. SECTION ( BFI )



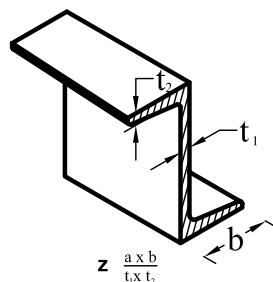
## 5- CHANNEL SECTION ( C )



## 6- T. SECTION ( T )

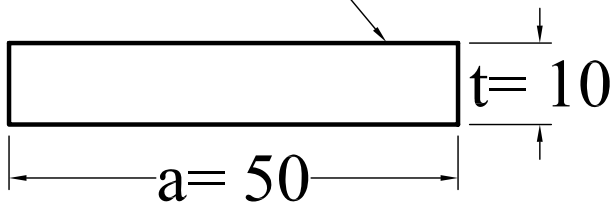


## 7- Z. SECTION ( Z )

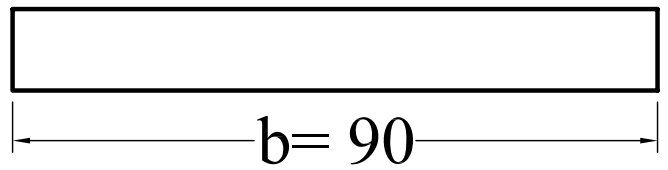


# 1- PLATE PL (a x b x t )

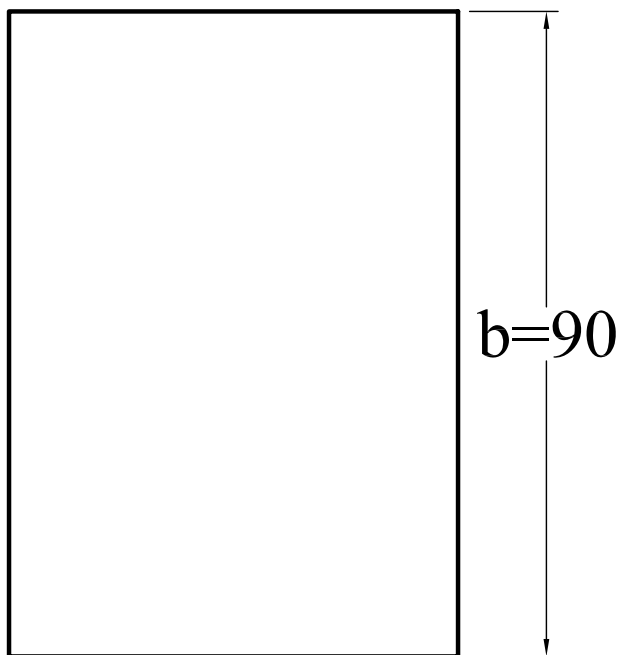
PL 50 x 90 x 10



ELEVATION

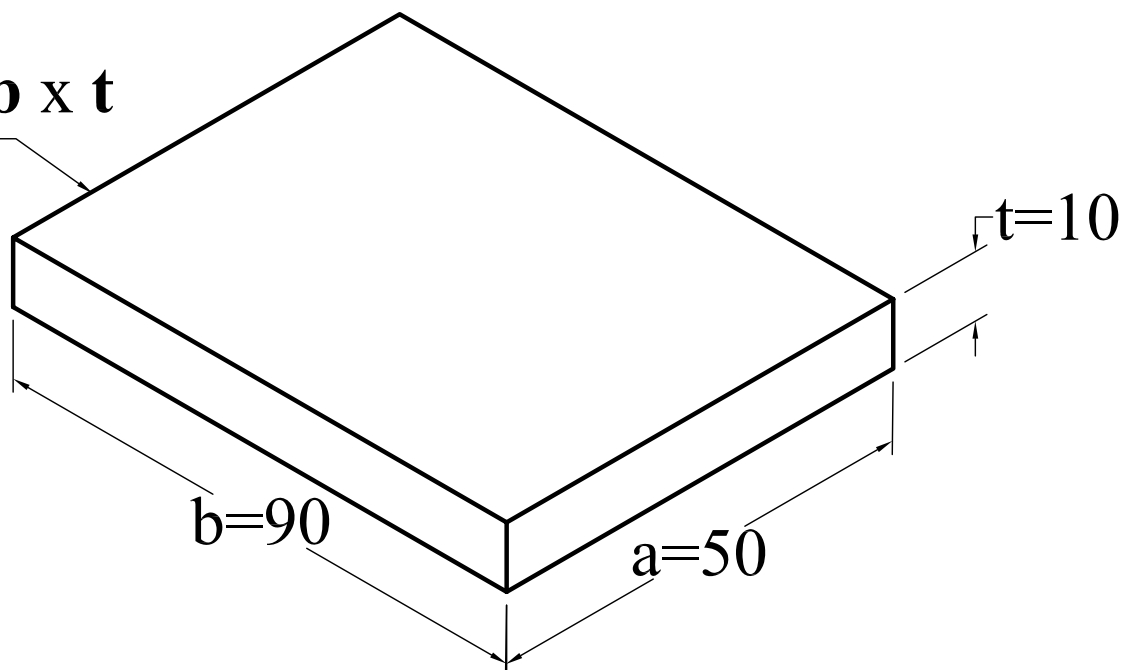


SIDE VIEW



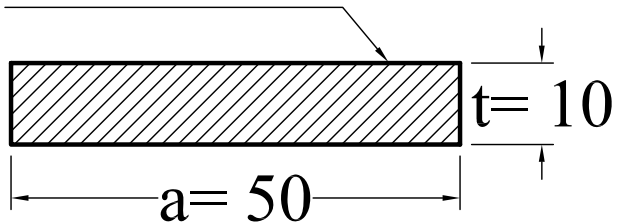
PLAN

PL a x b x t

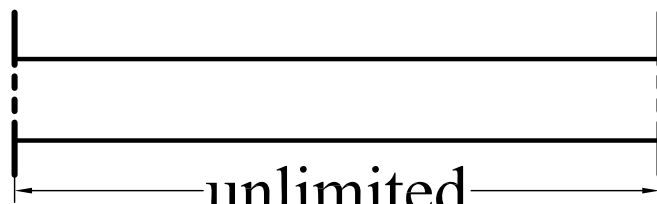


## 2- UNLIMITED PLATE PL (a x t )

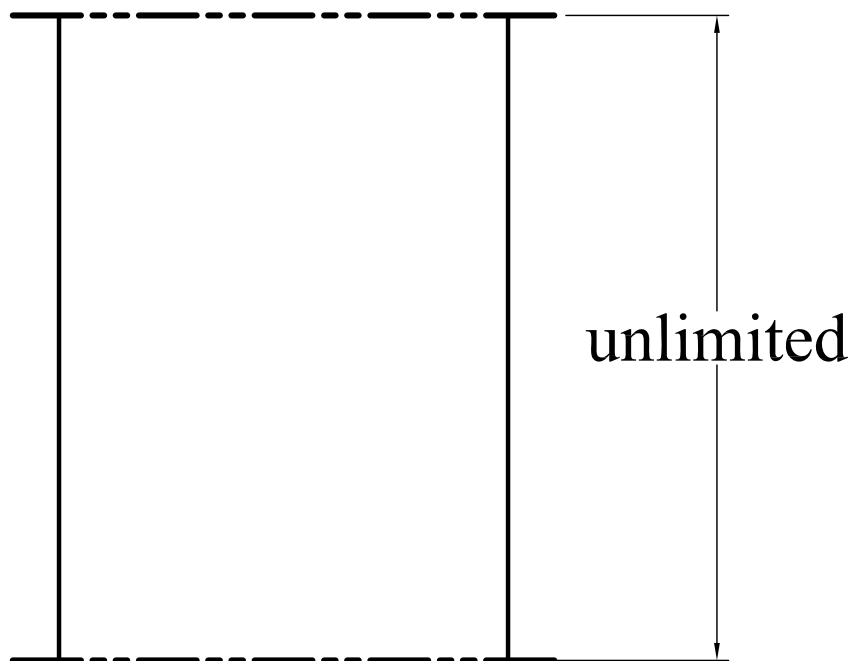
PL 50 x 10



ELEVATION

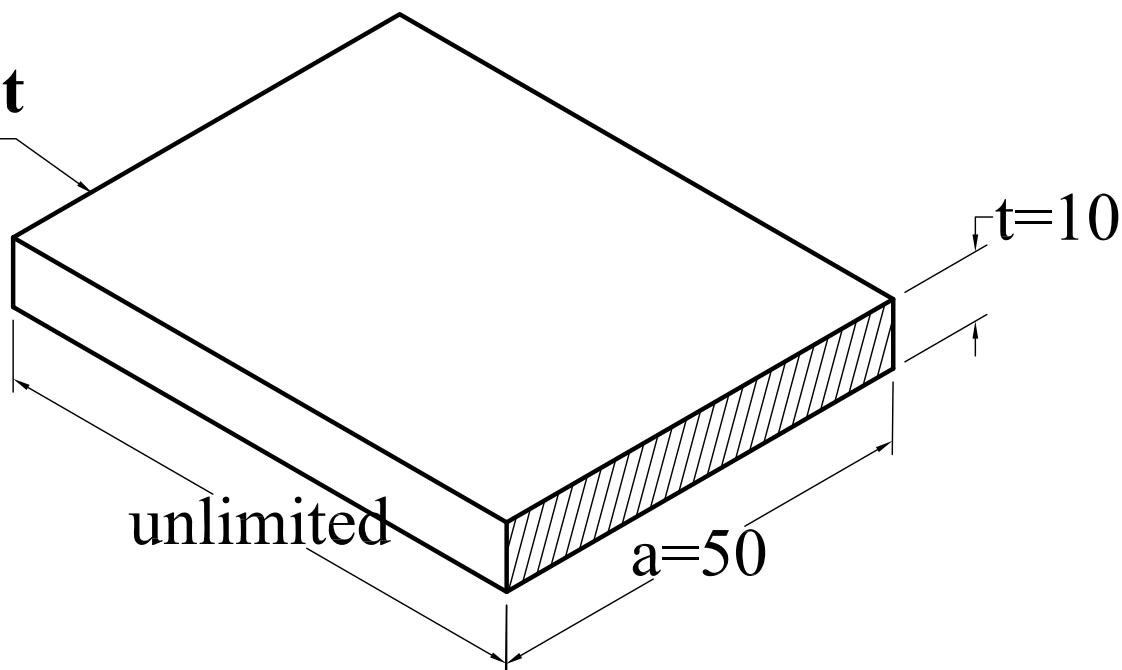


SIDE VIEW



PLAN

PL a x t

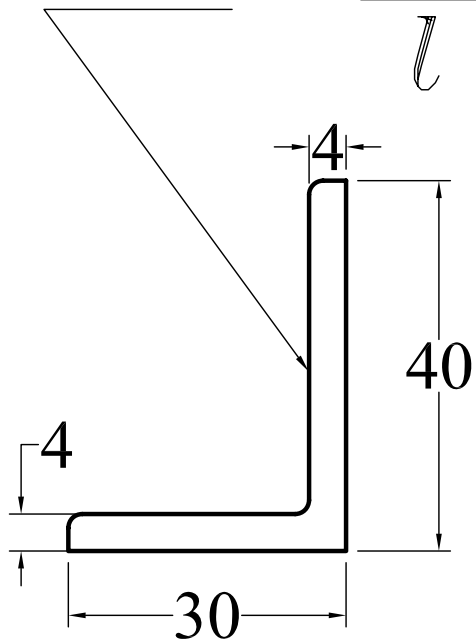




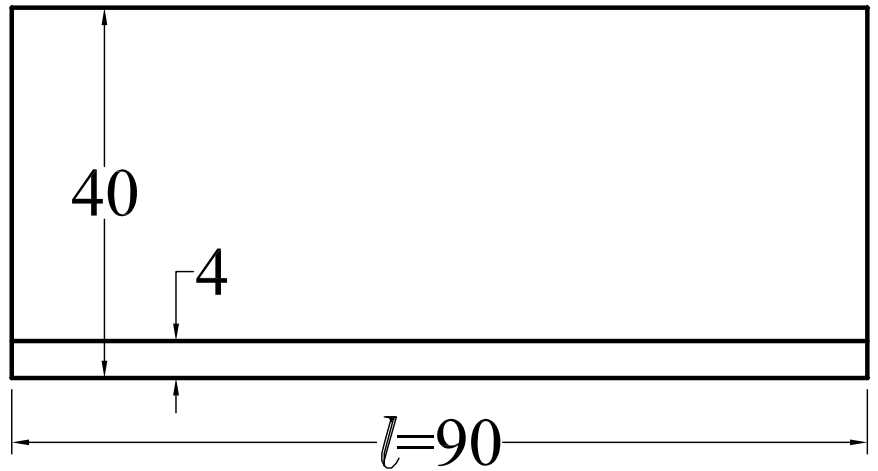
### 3- ANGLE L (a x b x t )

L 40 x 30 x 4

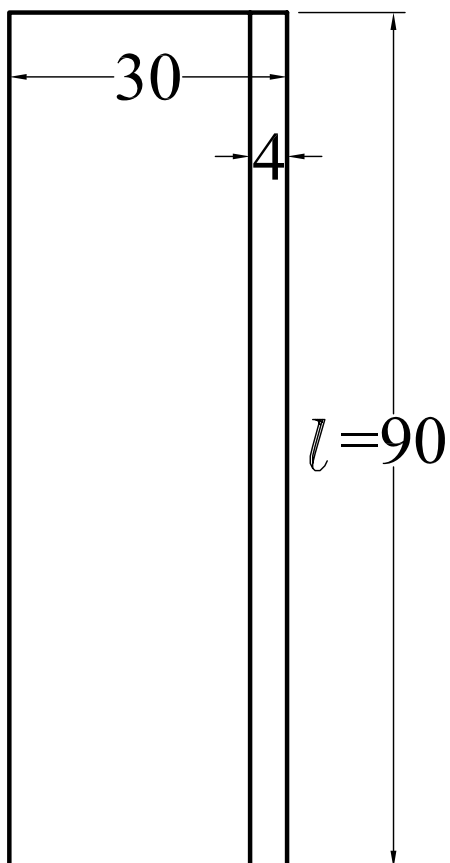
$$l = 90$$



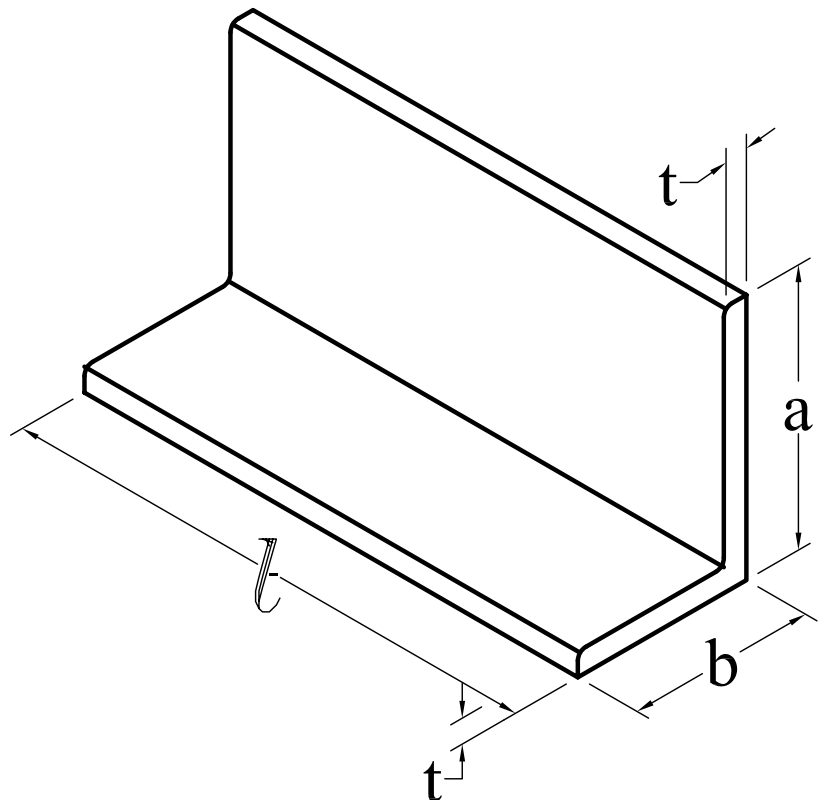
ELEVATION

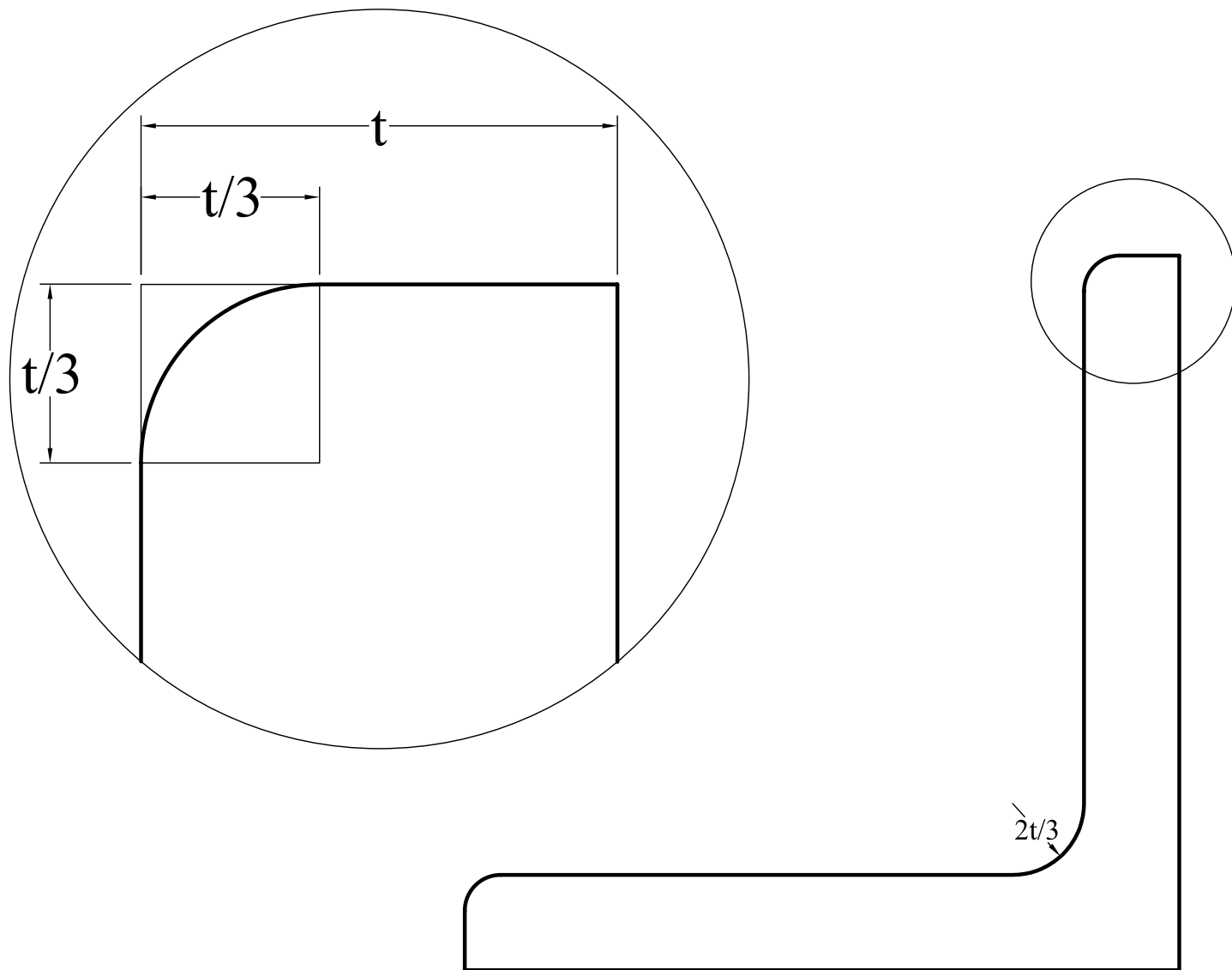


SIDE VIEW

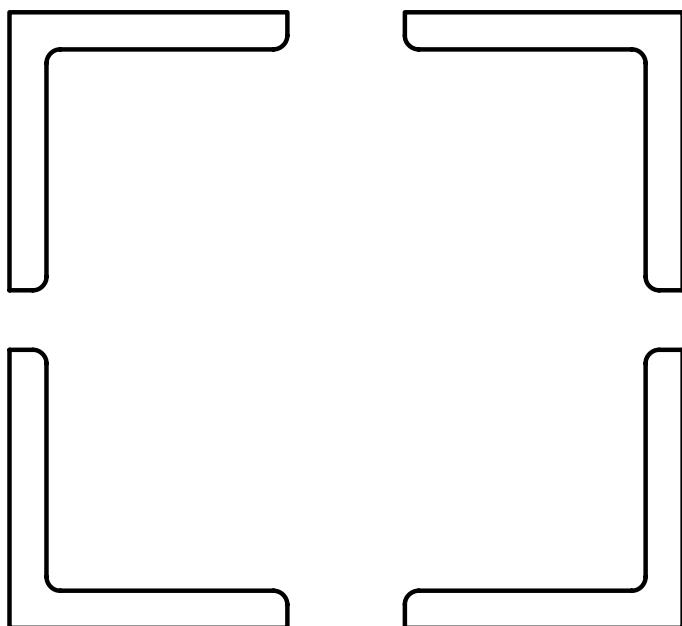


PLAN



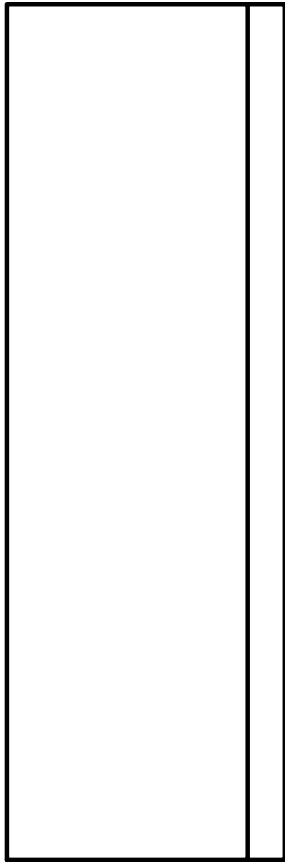
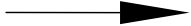


## POSSIBLE POSITIONS



L 30 x 30 x 4

$\ell = 90$



ELEVATION



+ +

+

+ +

+

SIDE VIEW

+

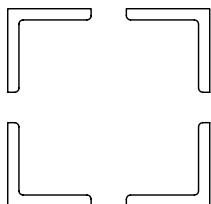
+

+

+

+ +

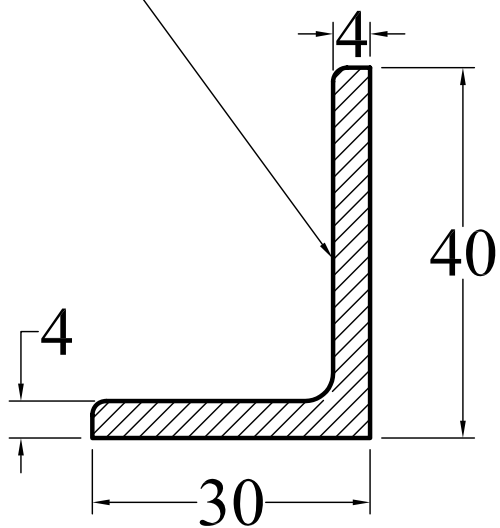
PLAN



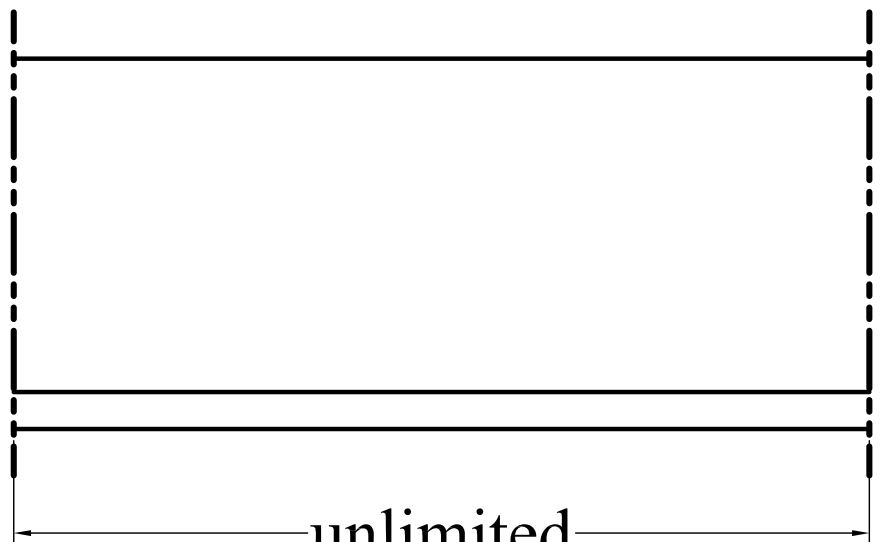
EX.

# 4- UNLIMITED ANGLE L (a x b x t )

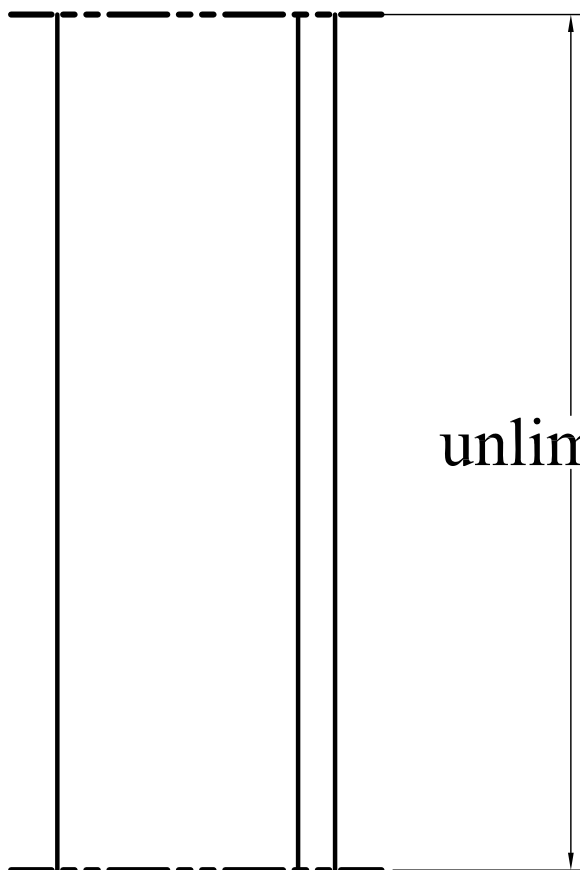
L 40 x 30 x 4



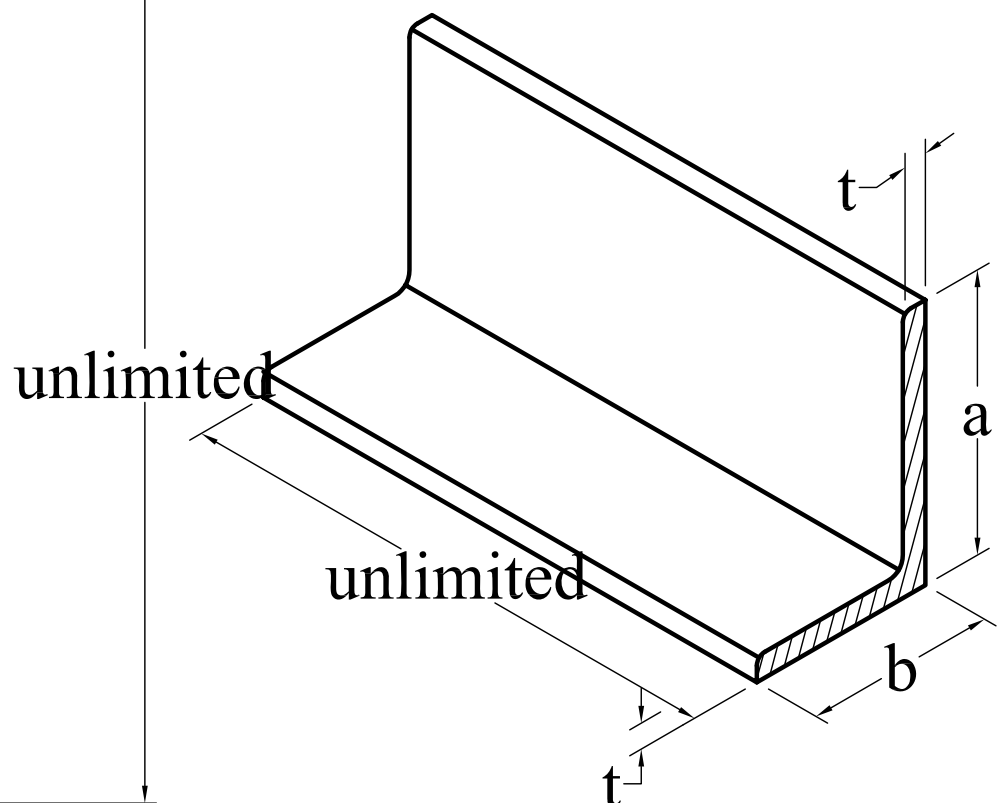
ELEVATION



unlimited  
SIDE VIEW

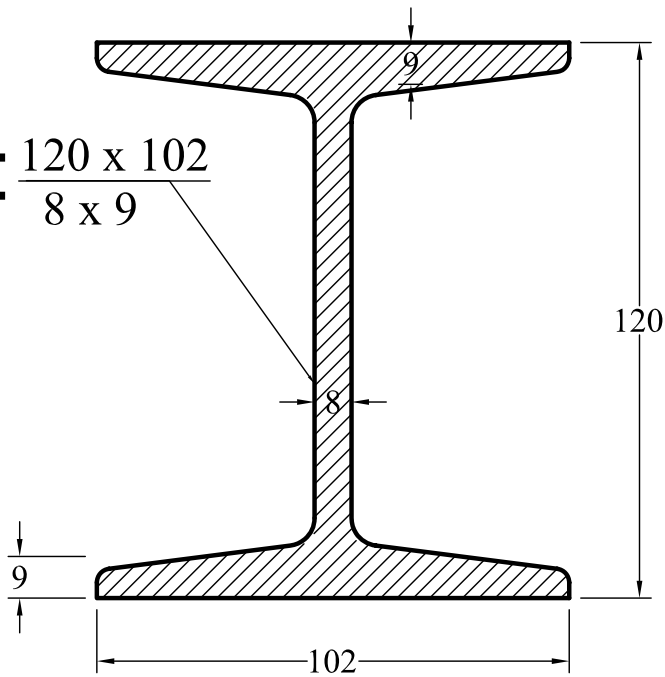


PLAN

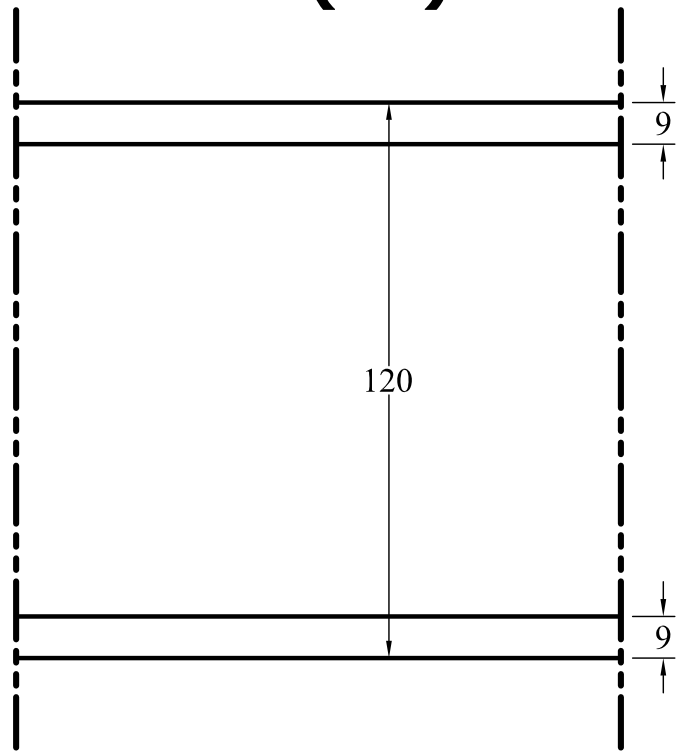


# 5- STANDARD I SECTION (SI)

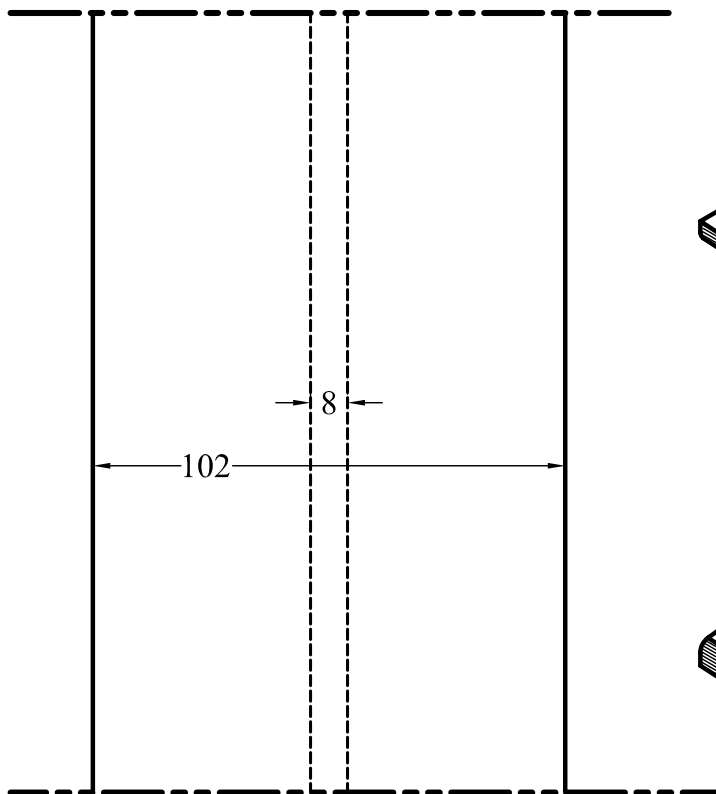
**SI**  $\frac{120 \times 102}{8 \times 9}$



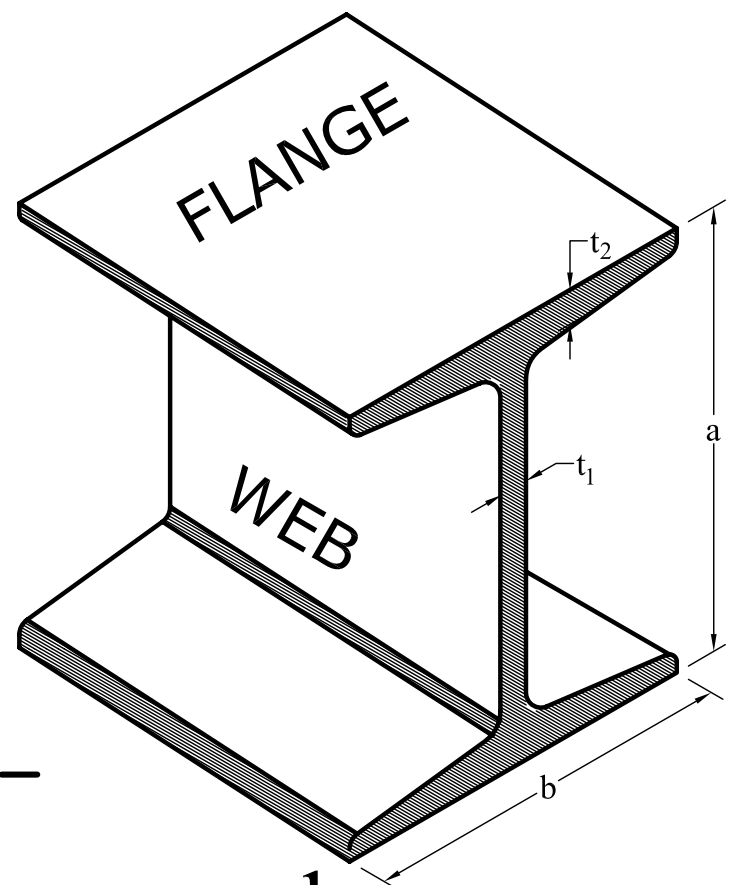
ELEVATION



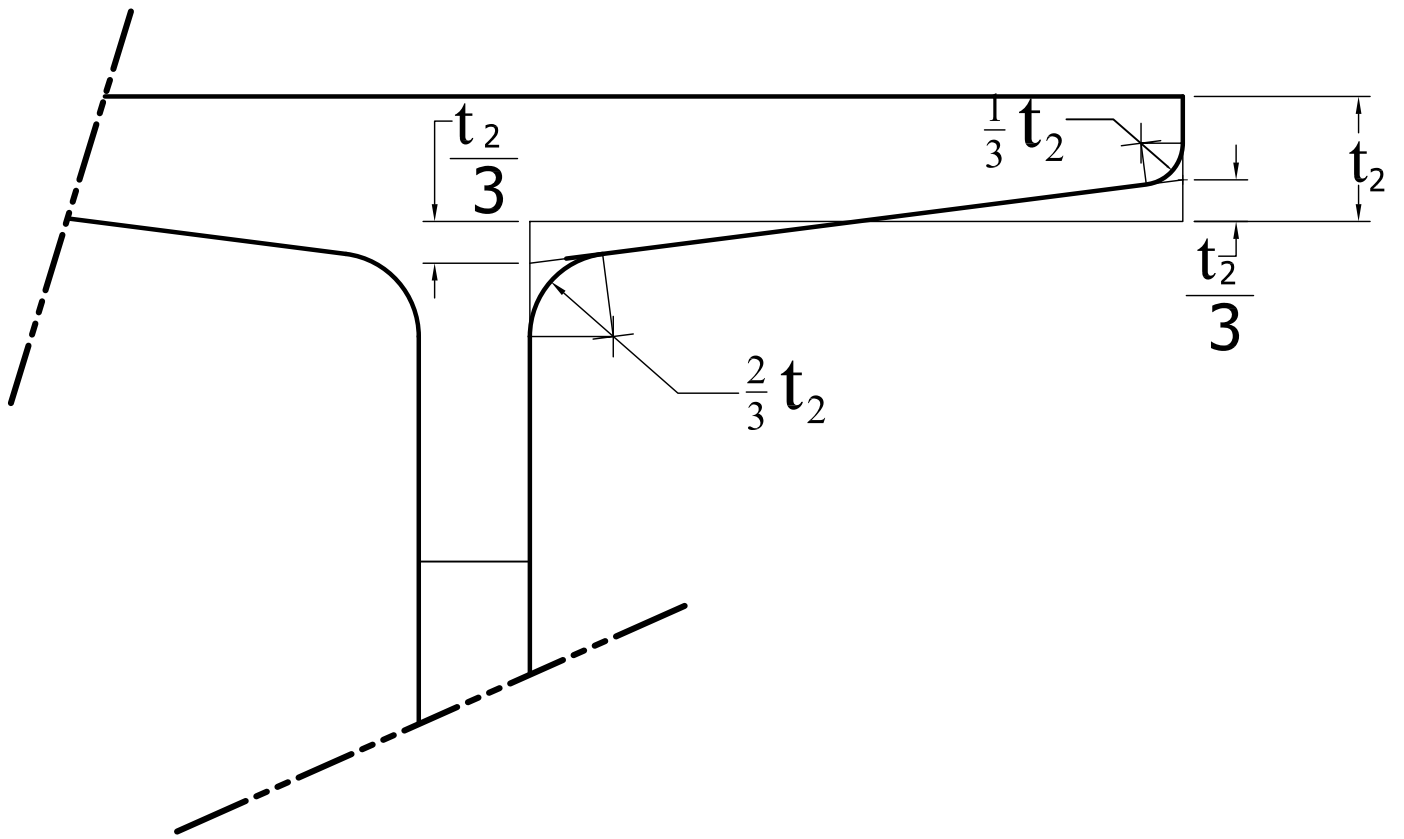
SIDE VIEW



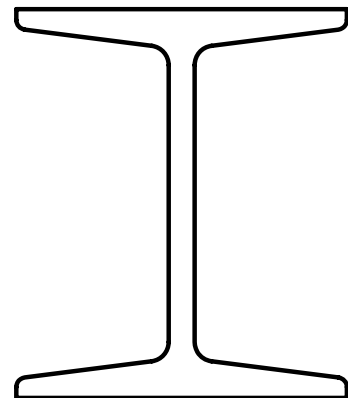
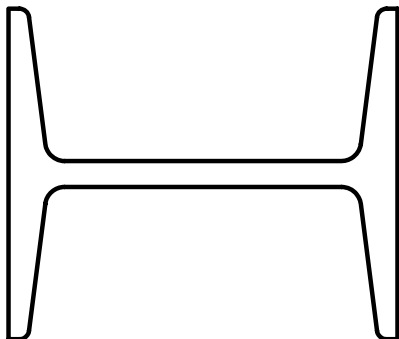
PLAN



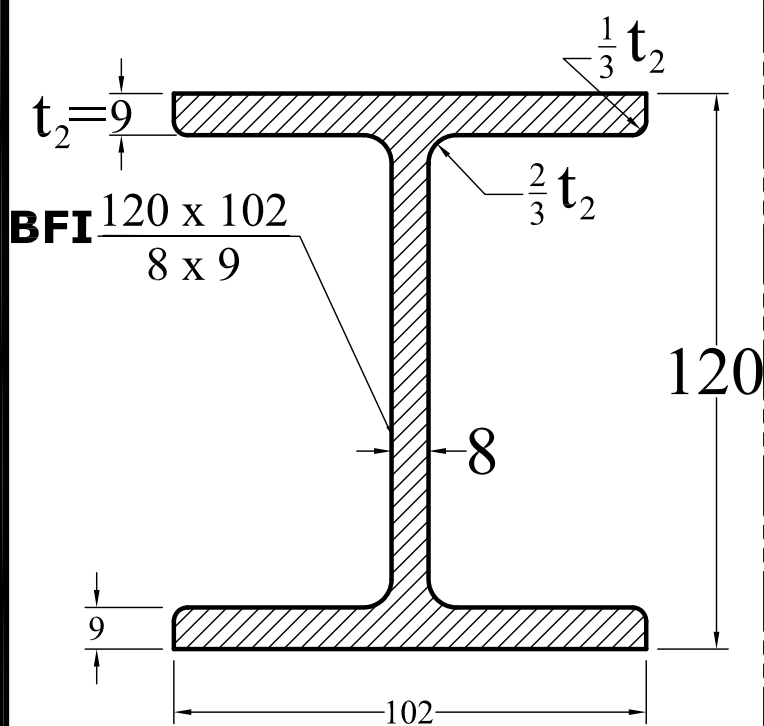
**SI**  $\frac{a \times b}{t_1 \times t_2}$



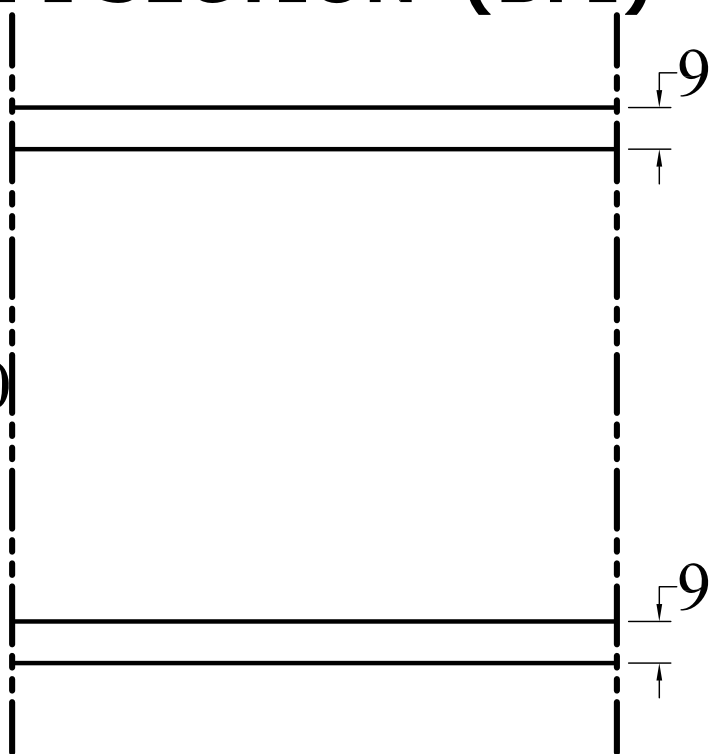
## POSSIBLE POSITIONS



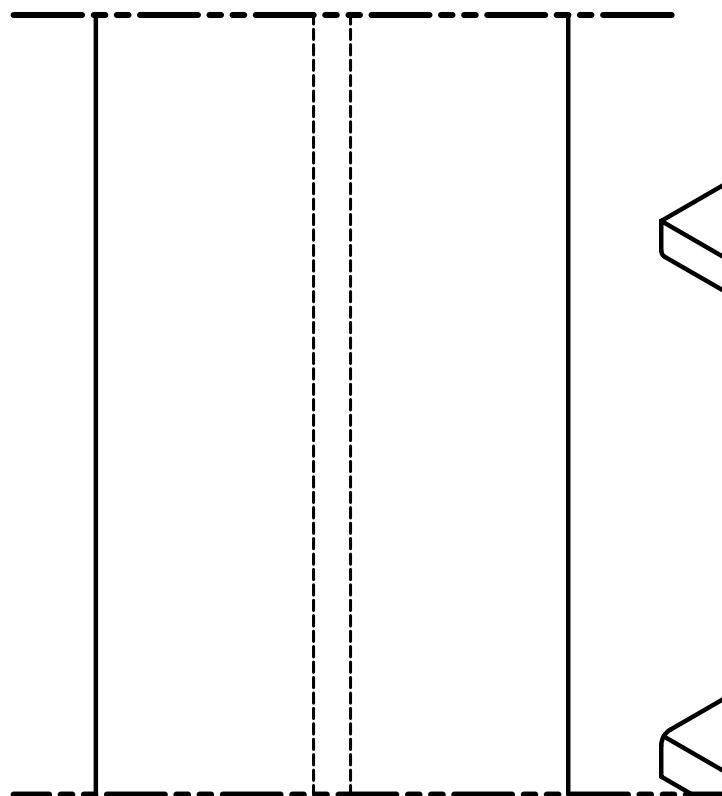
# 6- BROAD FLANGE I SECTION (BFI)



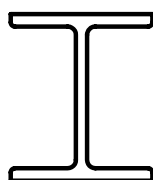
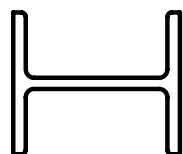
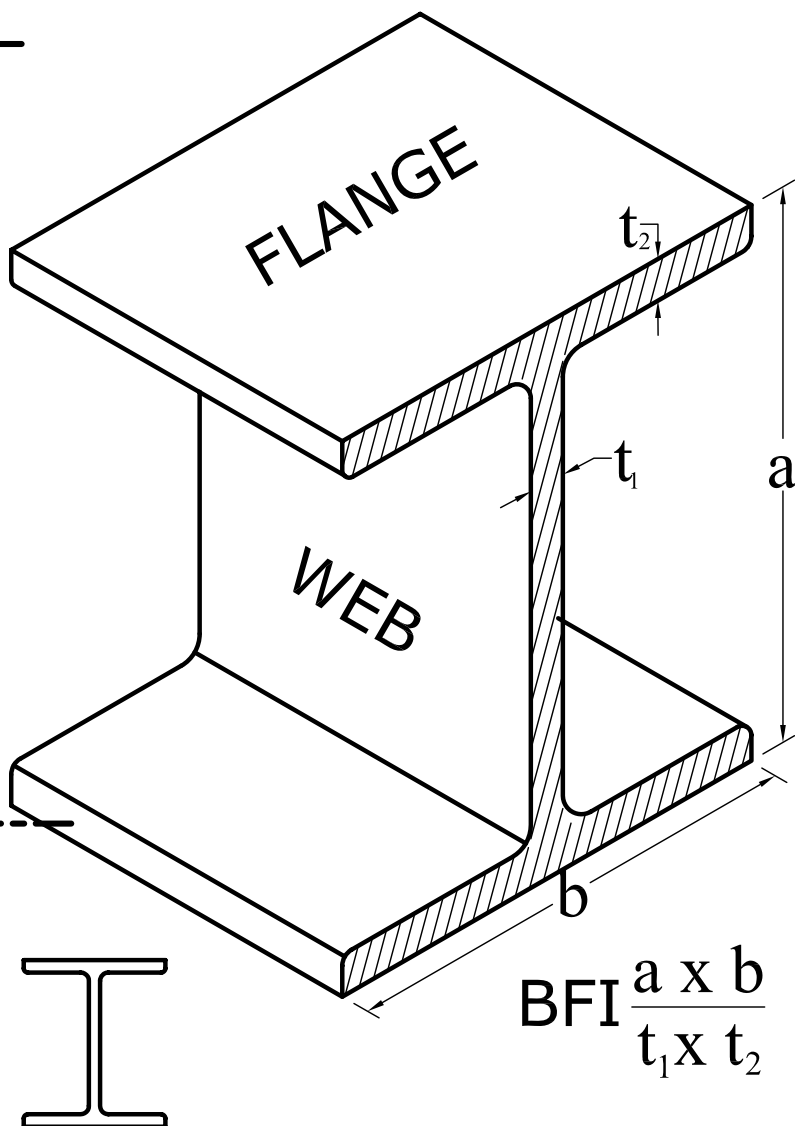
ELEVATION



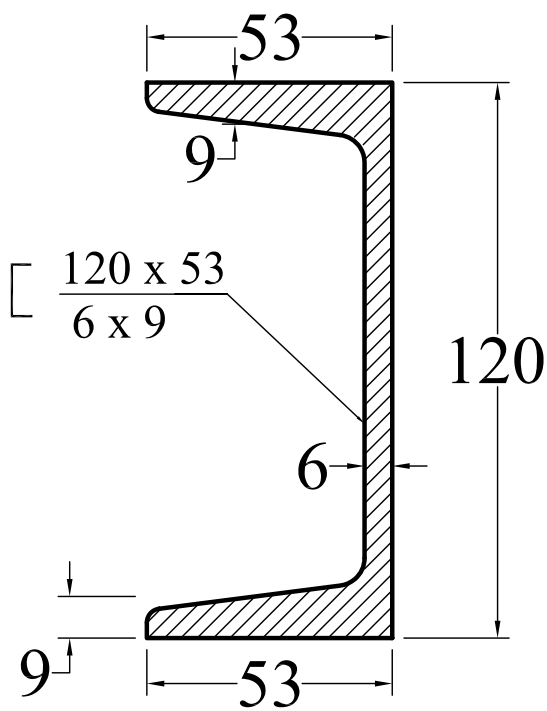
SIDE VIEW



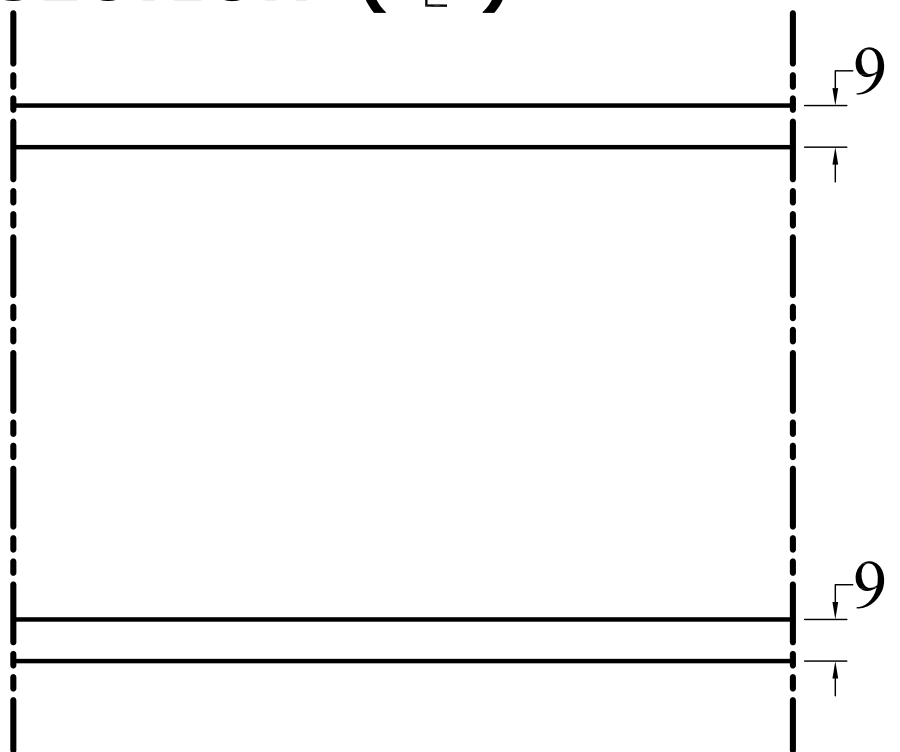
PLAN



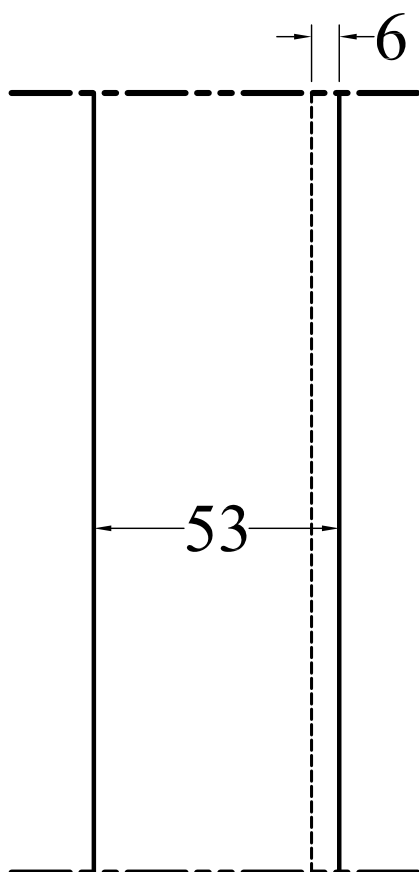
# 7- CHANNEL SECTION ( [ )



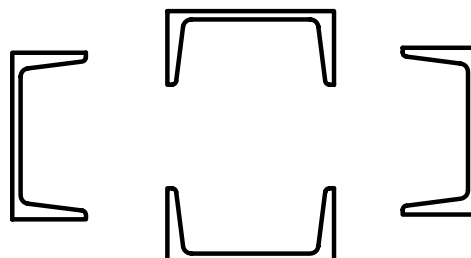
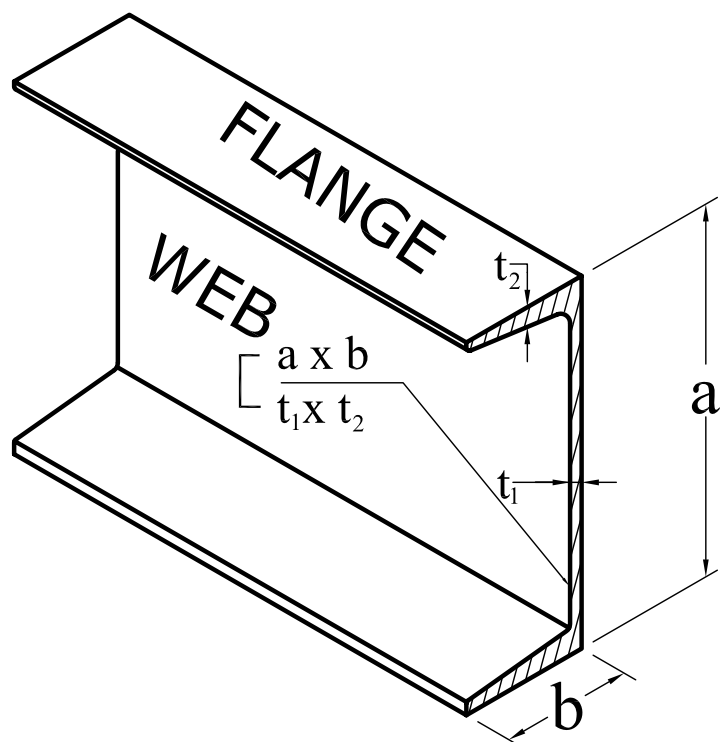
ELEVATION



SIDE VIEW

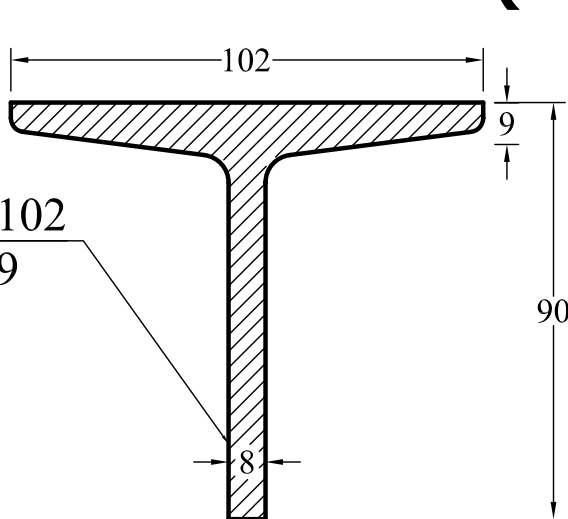


PLAN

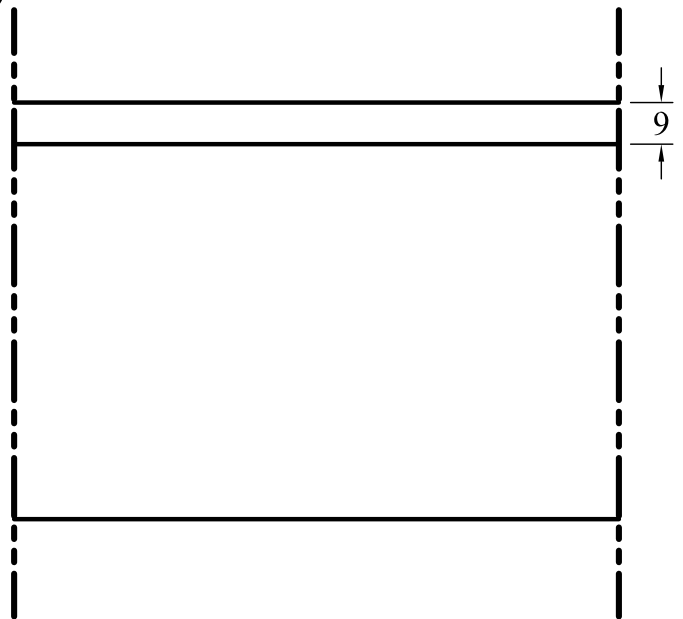




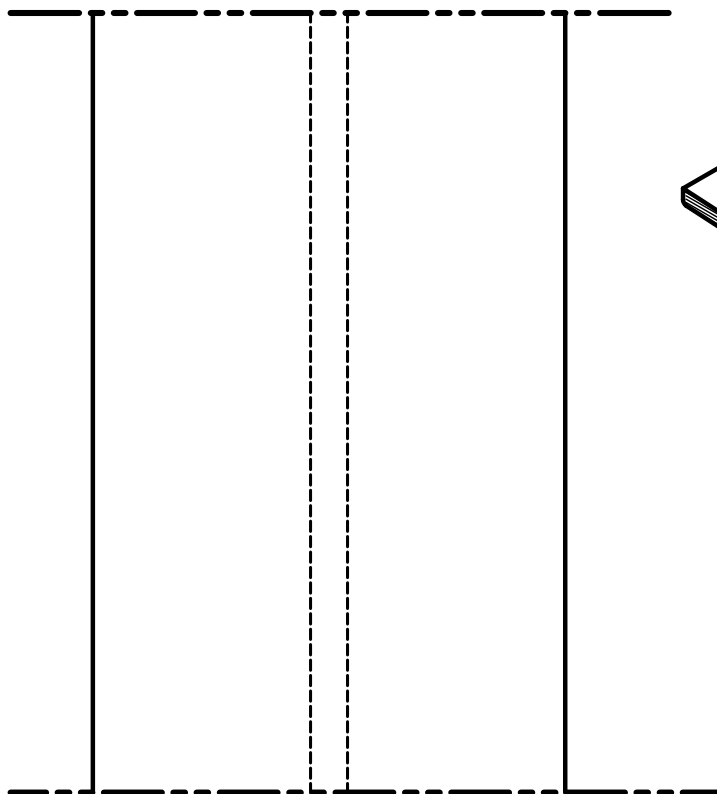
# 8- T SECTION (T)



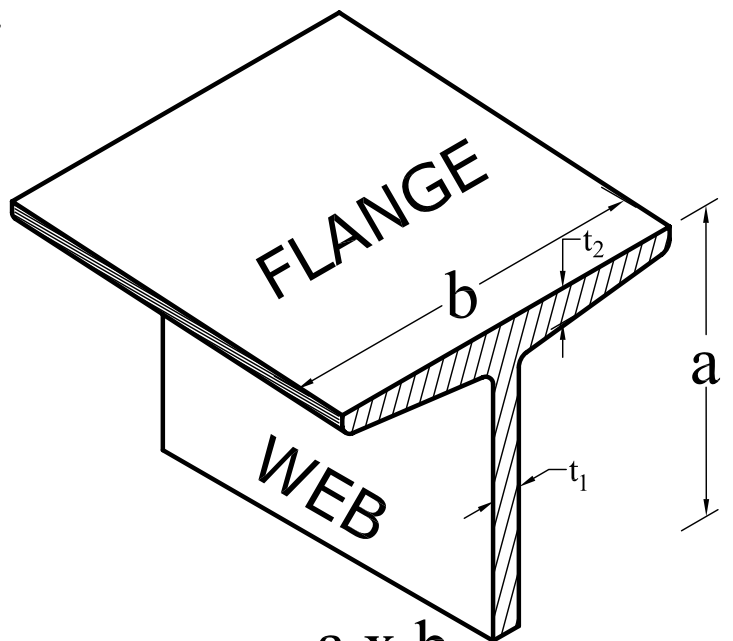
ELEVATION



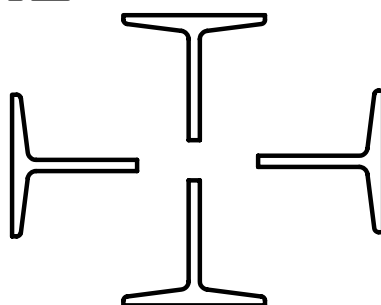
SIDE VIEW



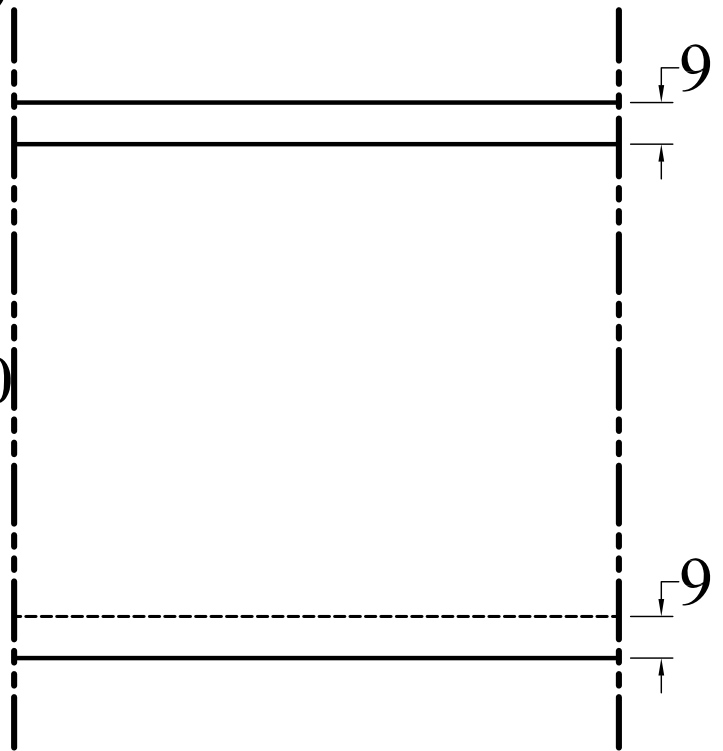
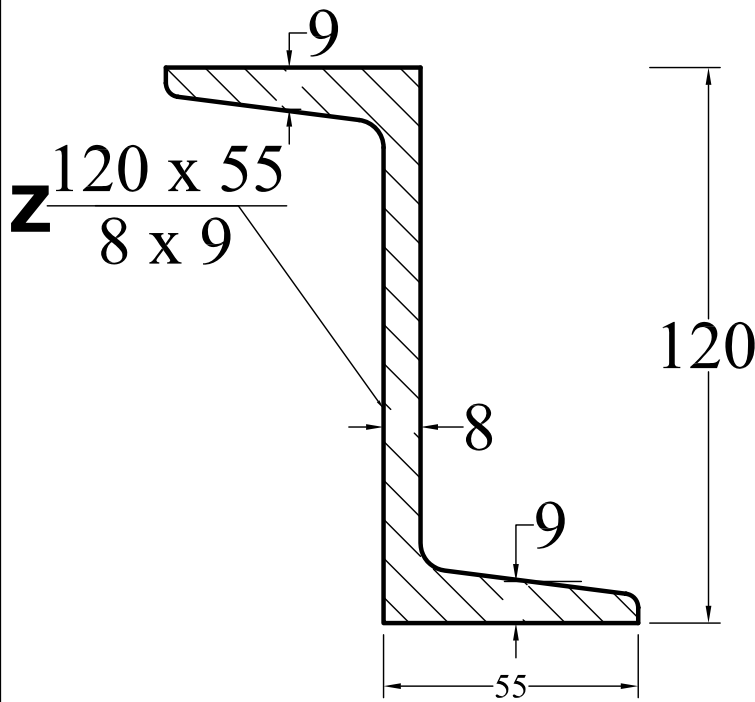
PLAN



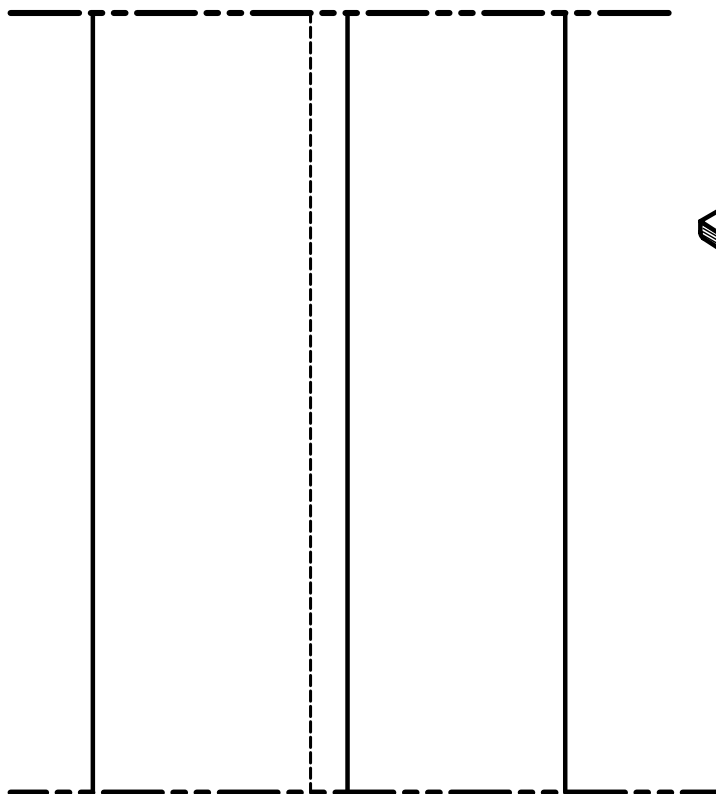
$$T \frac{a \times b}{t_1 \times t_2}$$



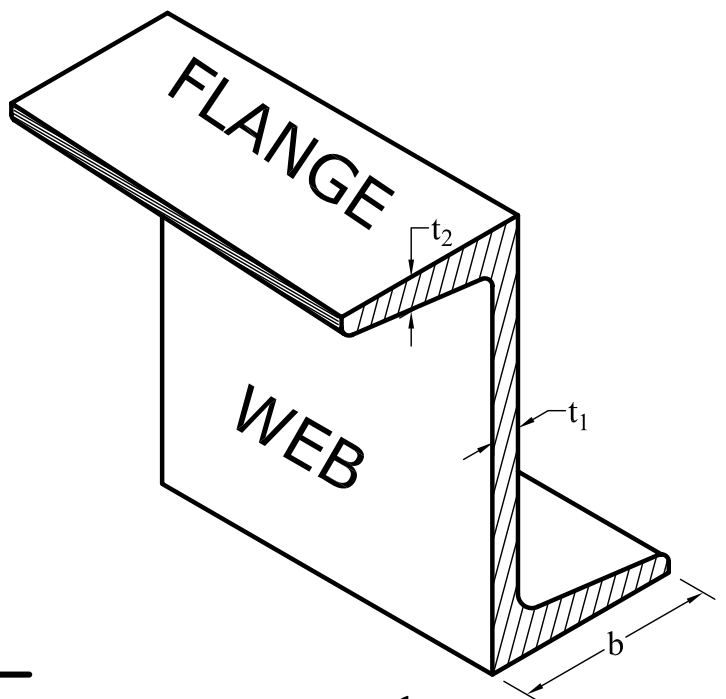
# 9- Z SECTION (Z)



SIDE VIEW



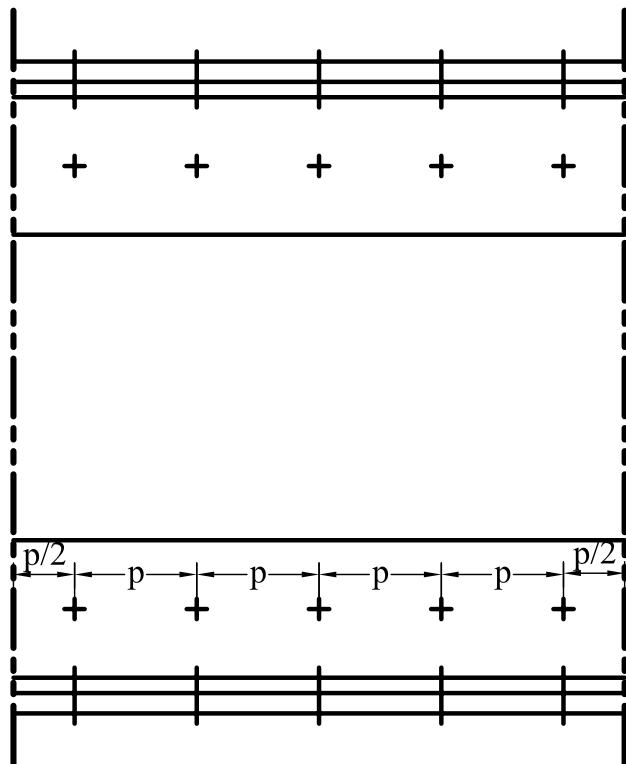
PLAN



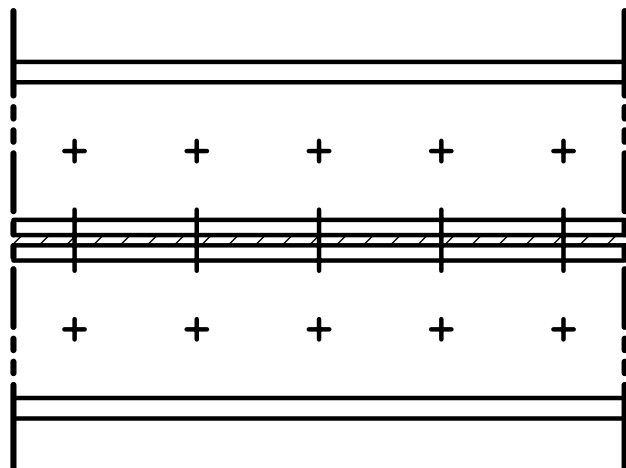
Z

$$\frac{a \times b}{t_1 \times t_2}$$

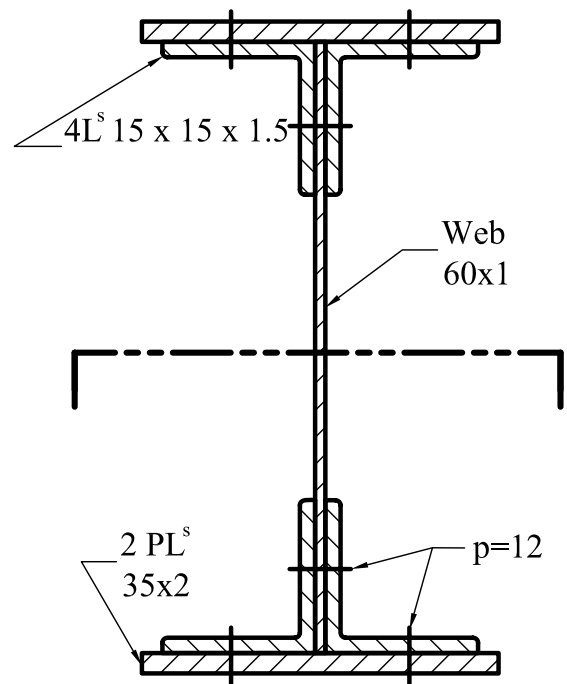
# 10- Compound or Built up Sections



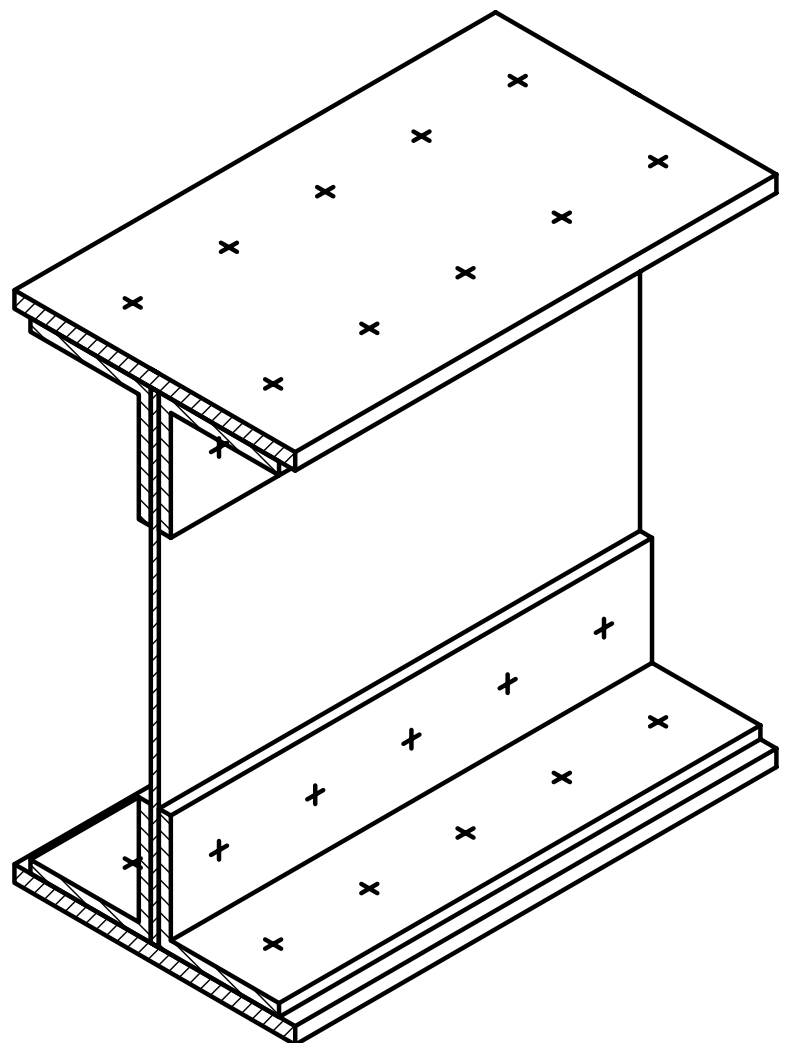
ELEVATION



SEC. PLAN



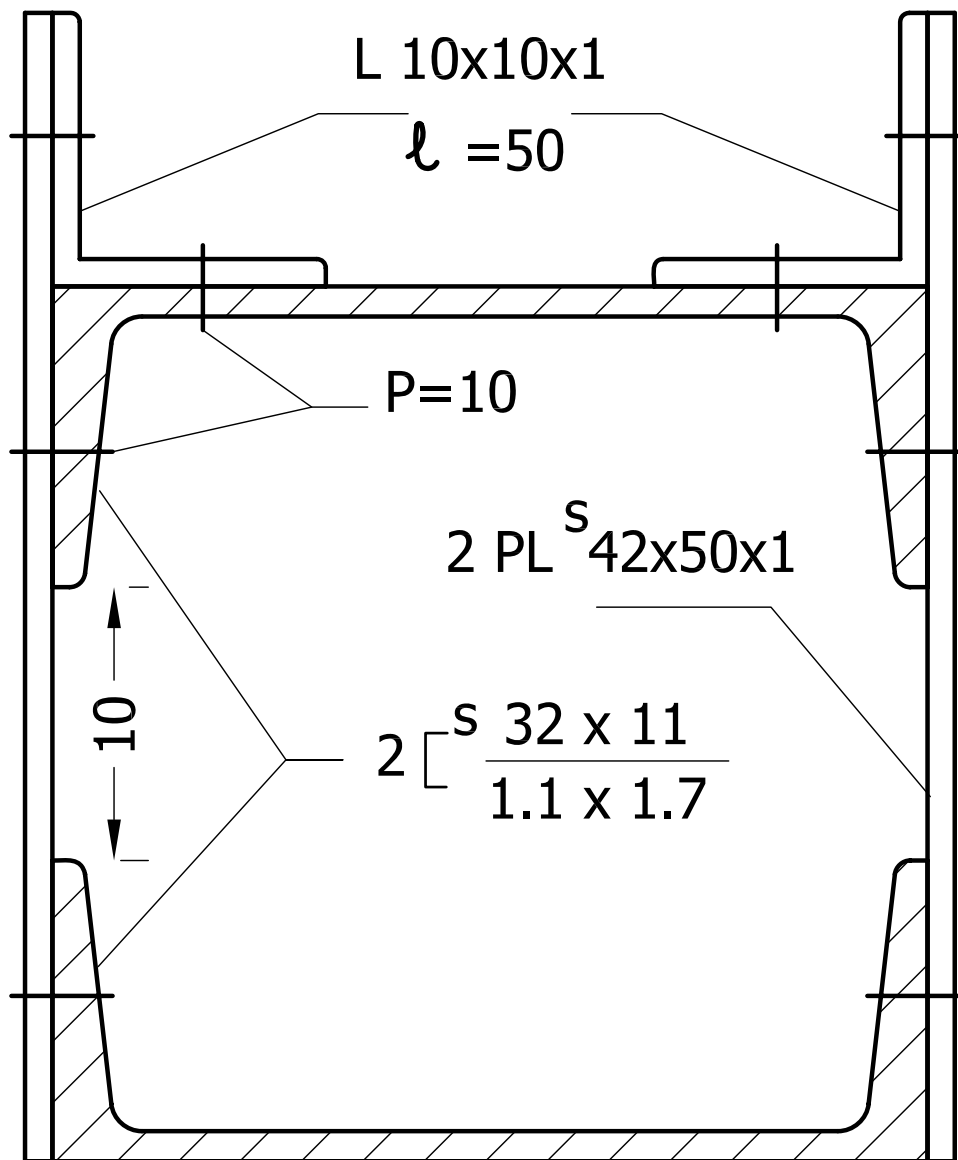
SIDE VIEW



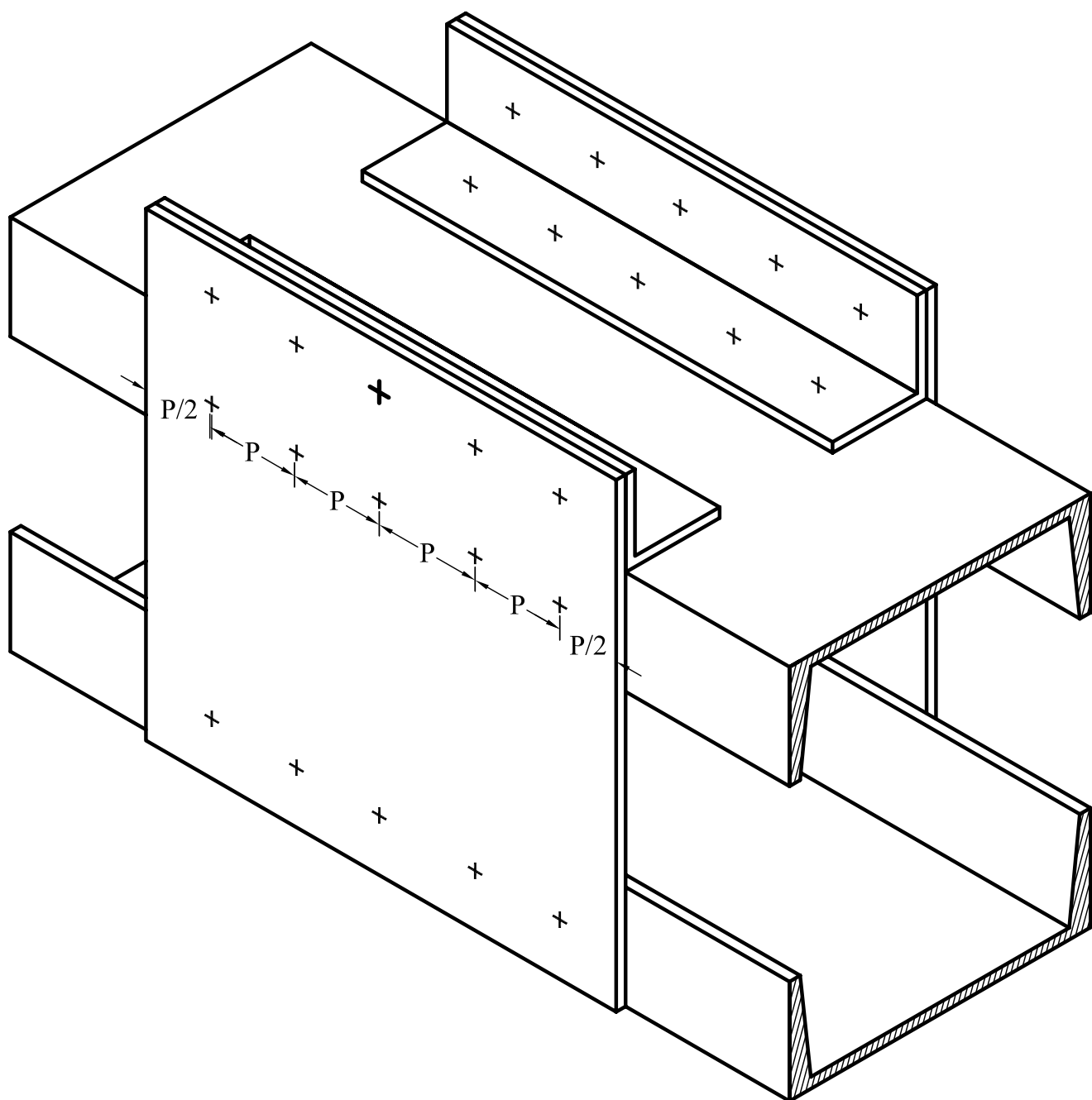
Draw section SIDE VIEW for  
the given steel joint.

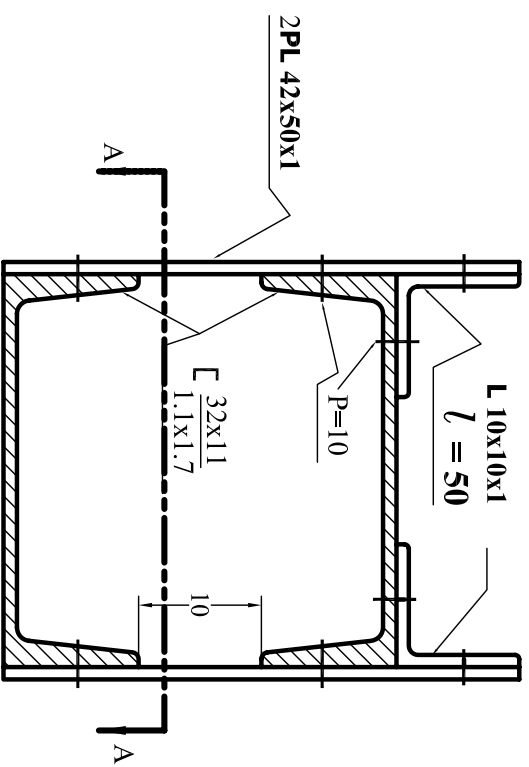
DIMS. IN CM.

SCALE 1:5

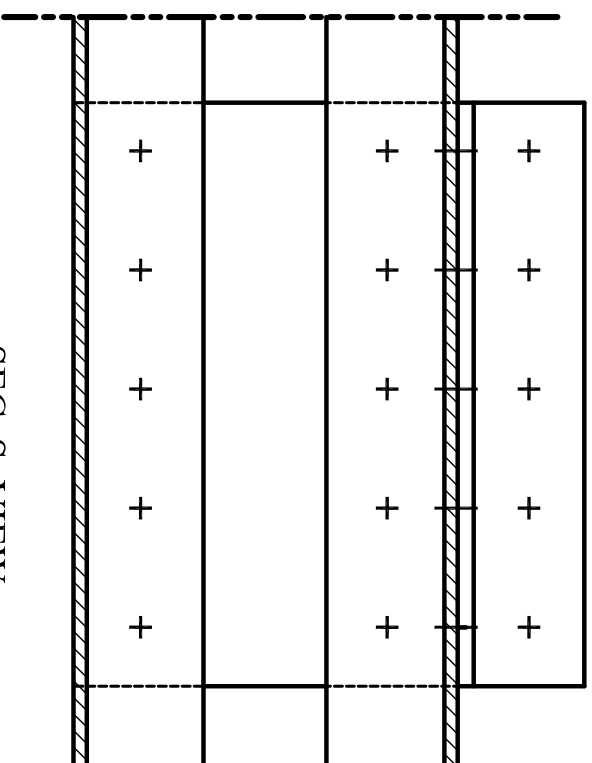


ELEV.

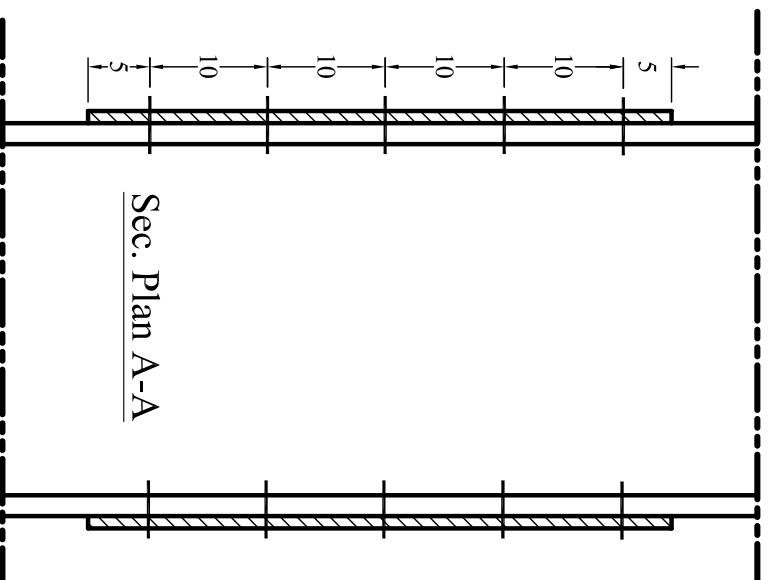




ELEVATION



SEC. S. VIEW

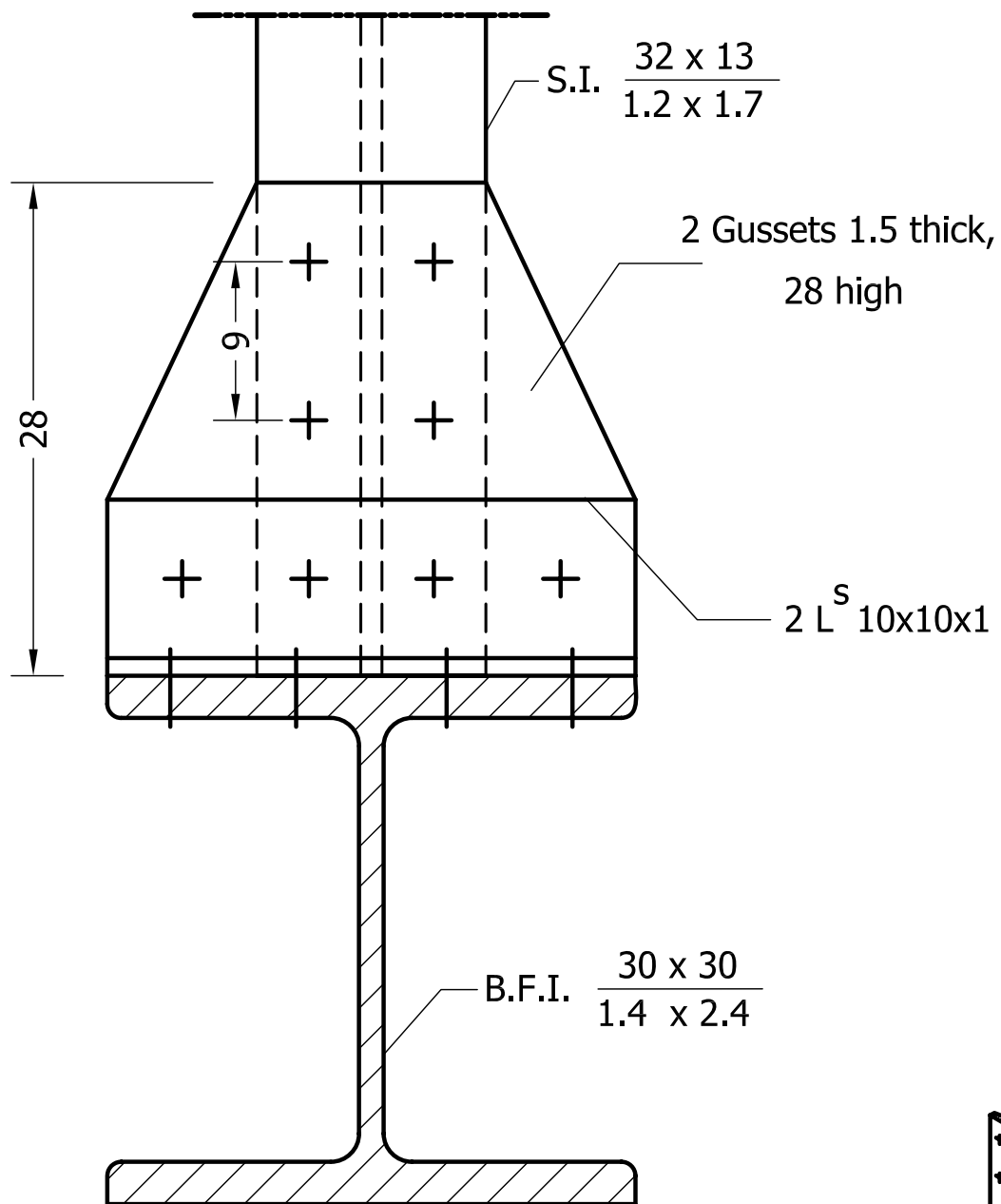


Sec. Plan A-A

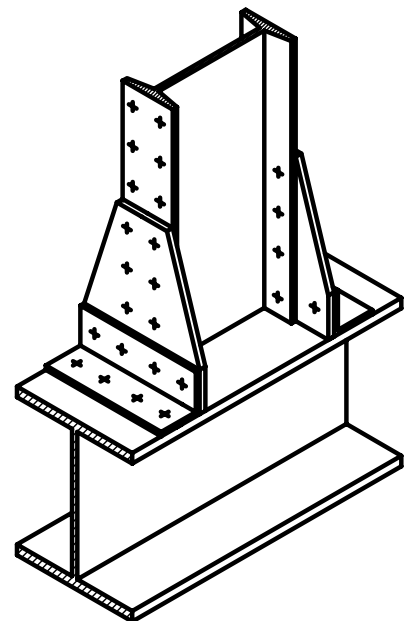
Draw the ELEVATION of the given steel joint.

DIMS. IN CM.

SCALE 1:5



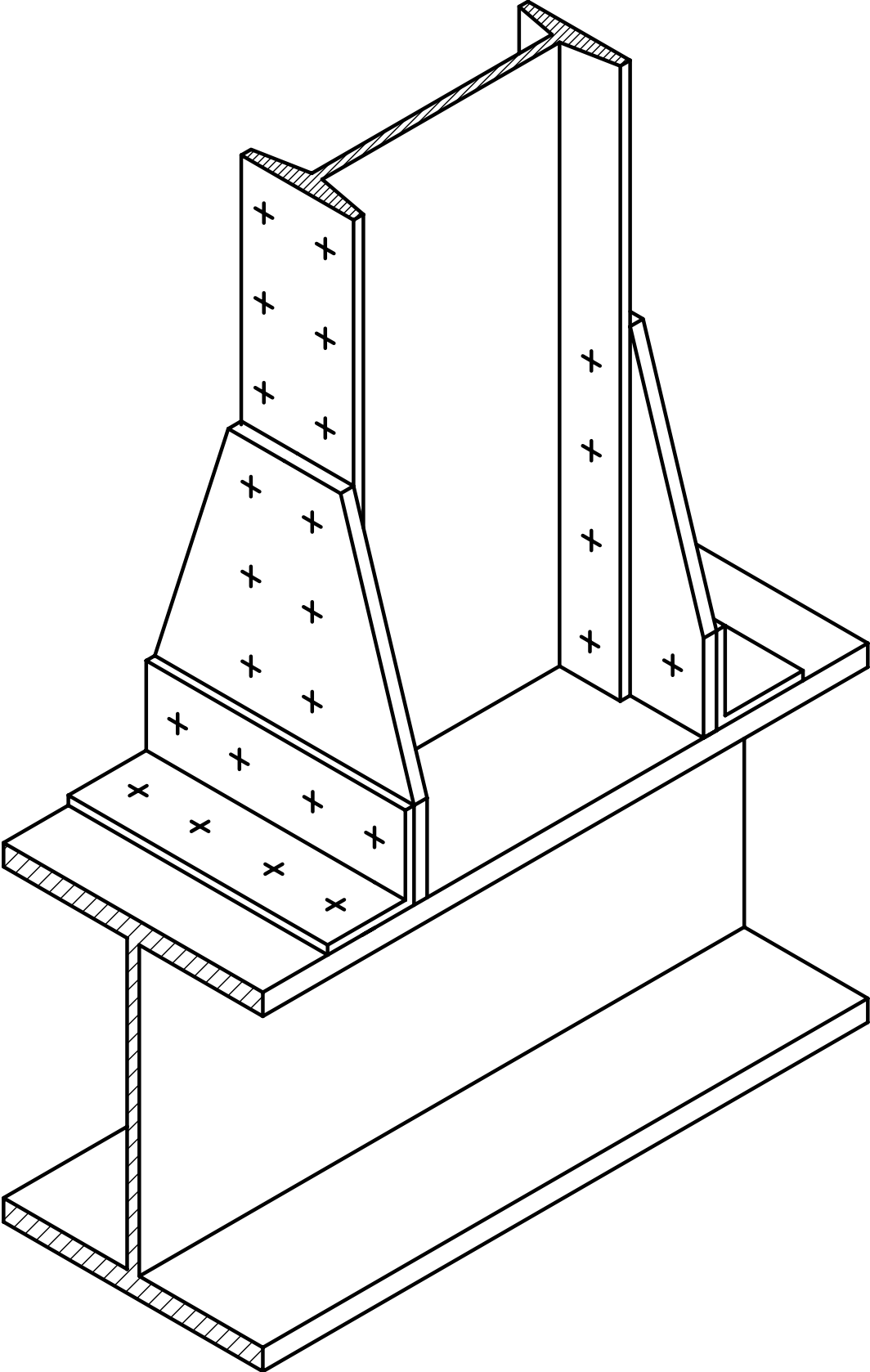
SIDE VIEW



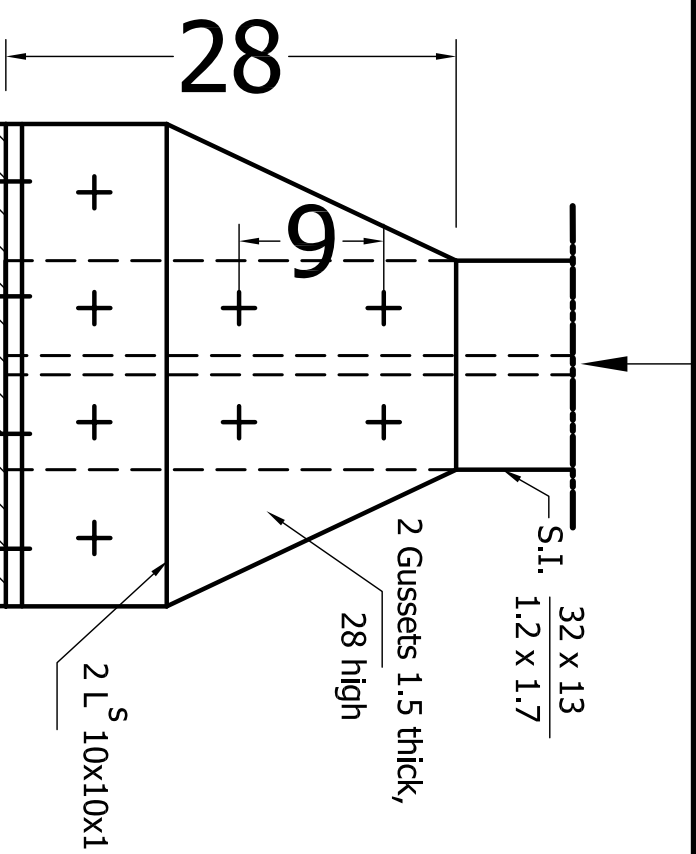
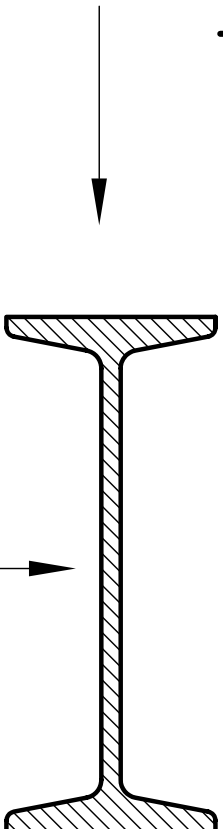
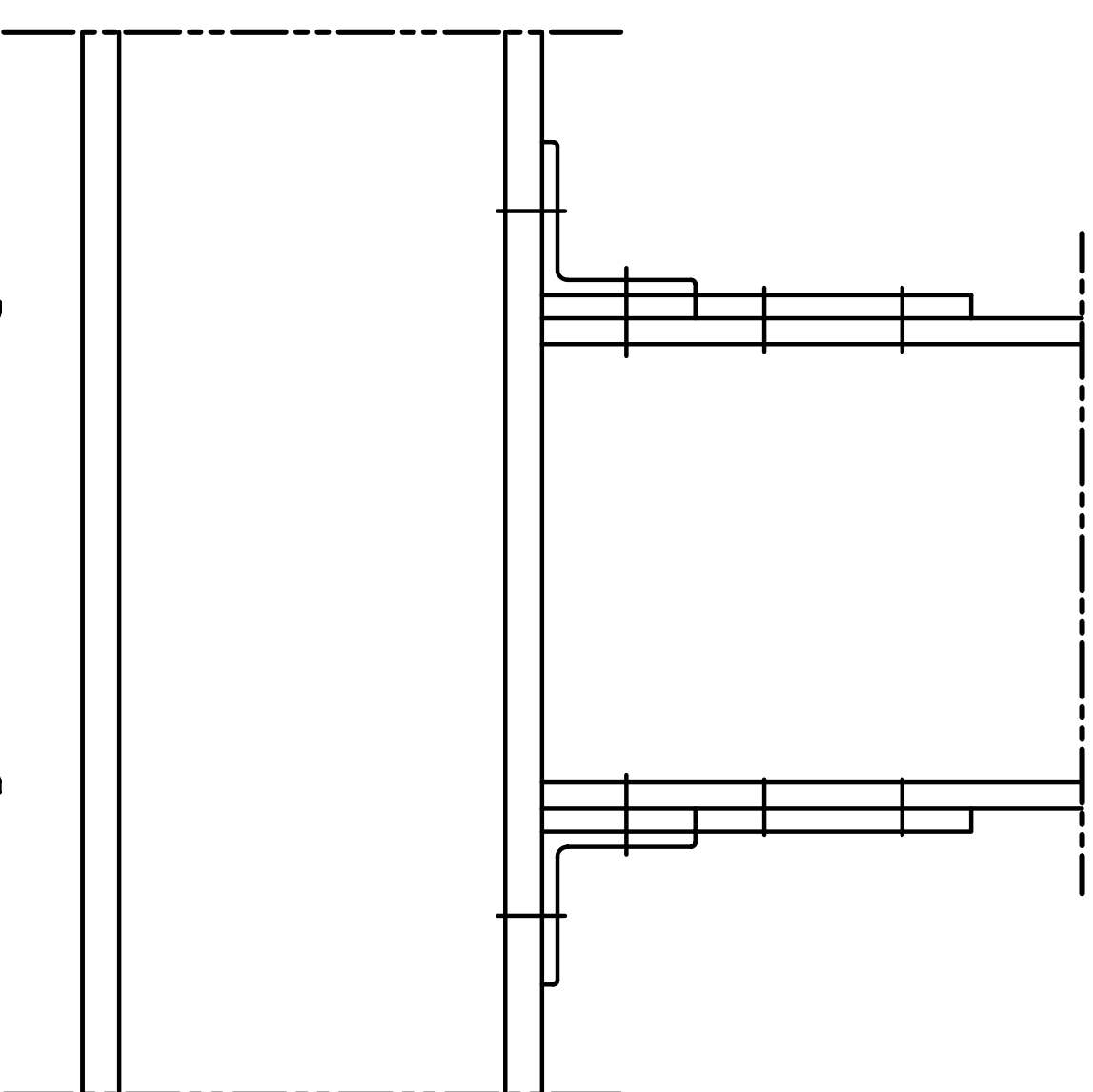
SCALE 1:5

30 cm      6 cm

1.4 cm    0.28 cm







SIDE VIEW

Draw

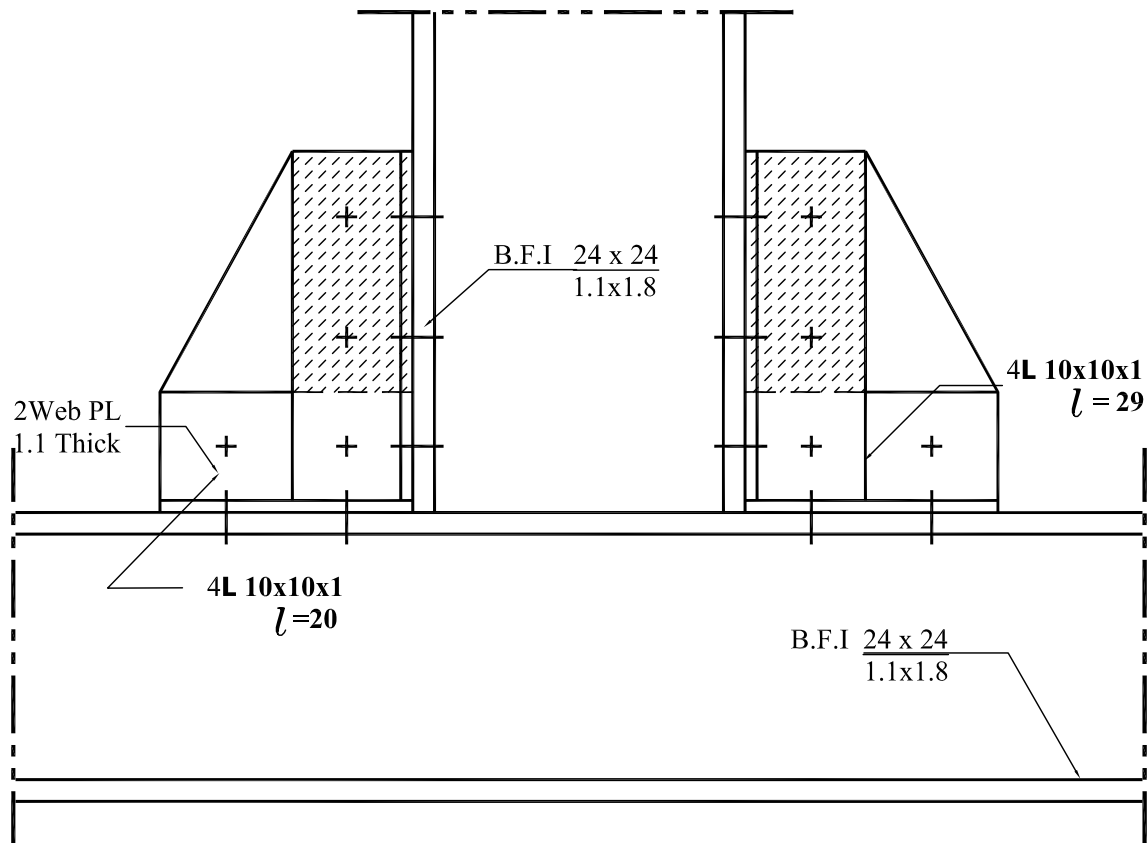
1- Elevation

2- Side View

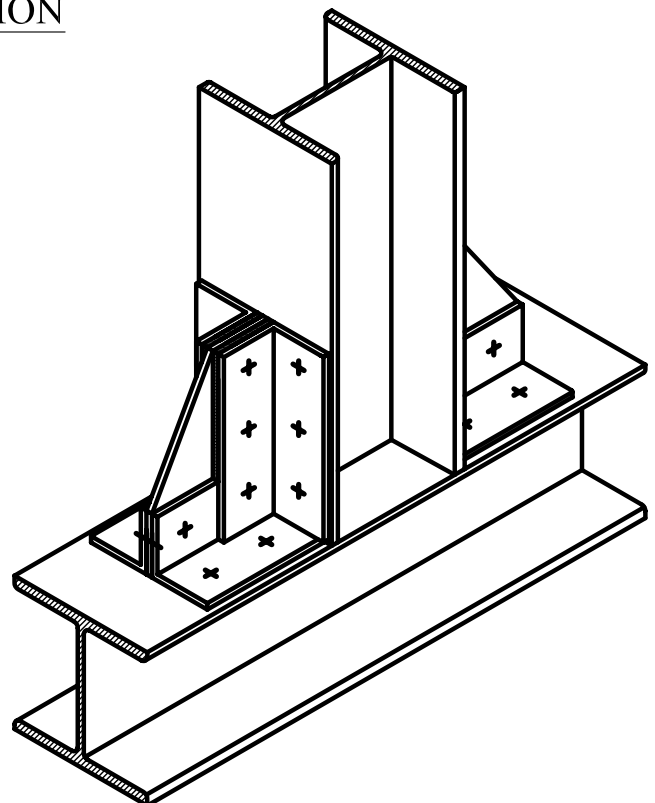
for the following steel joint.

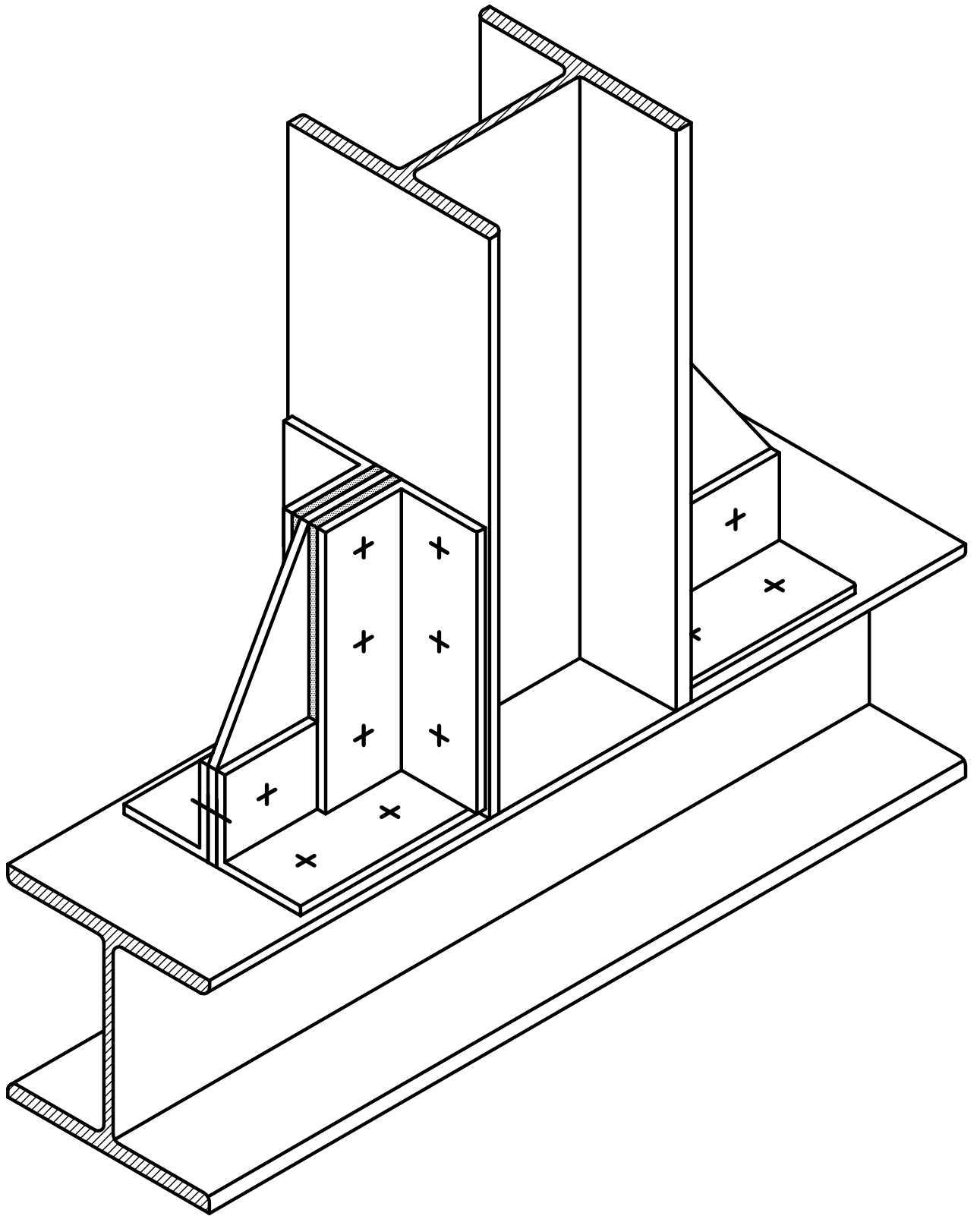
DIMS. IN CMS.

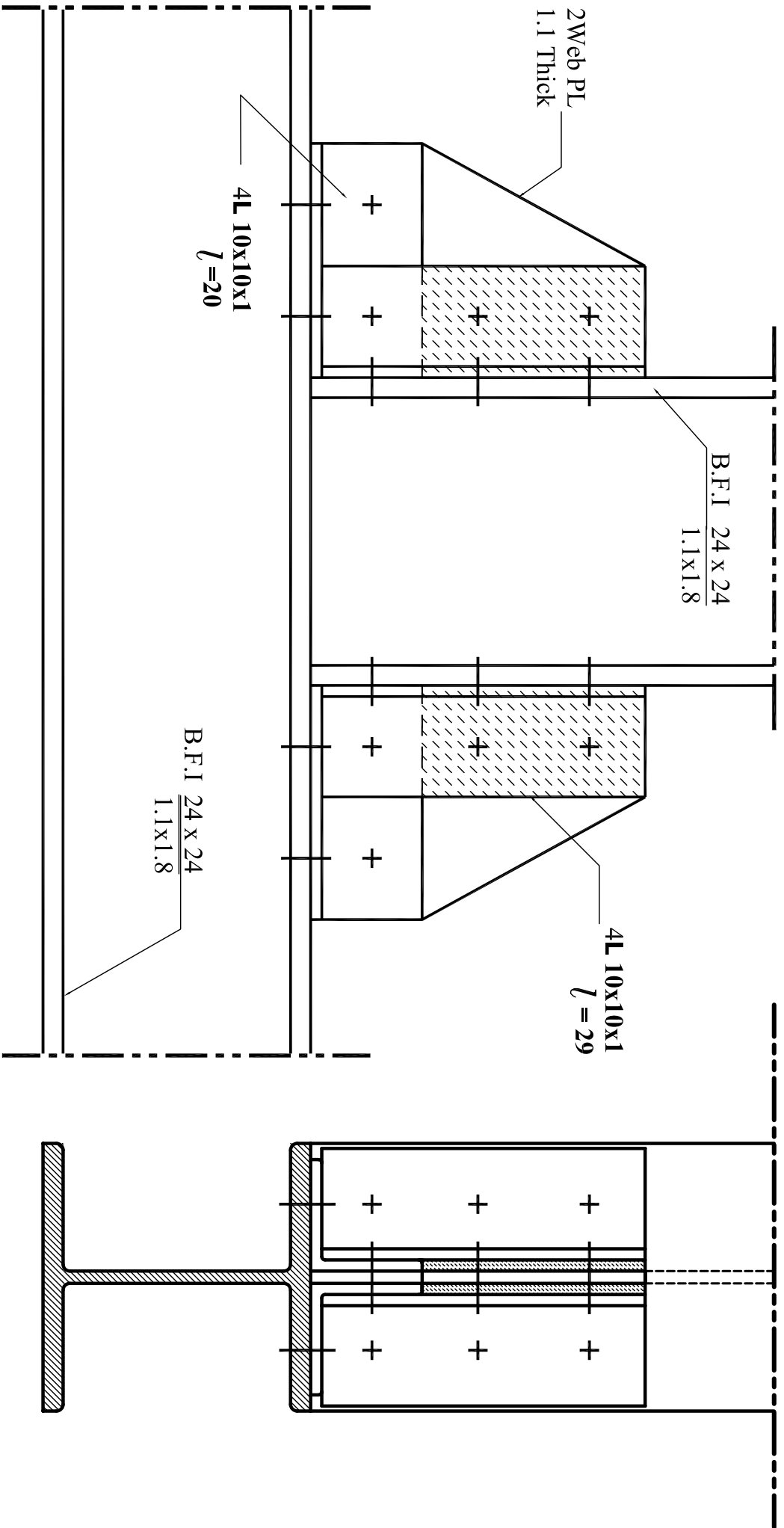
SCALE 1:5



ELEVATION







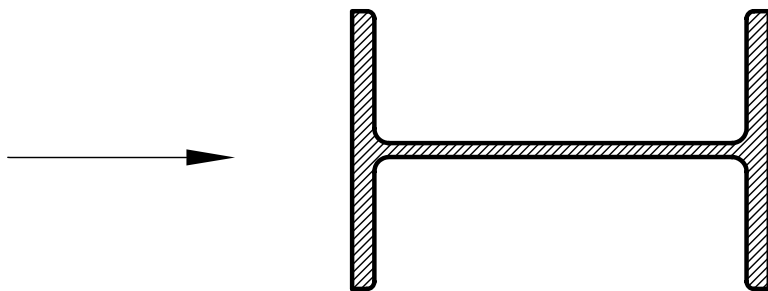
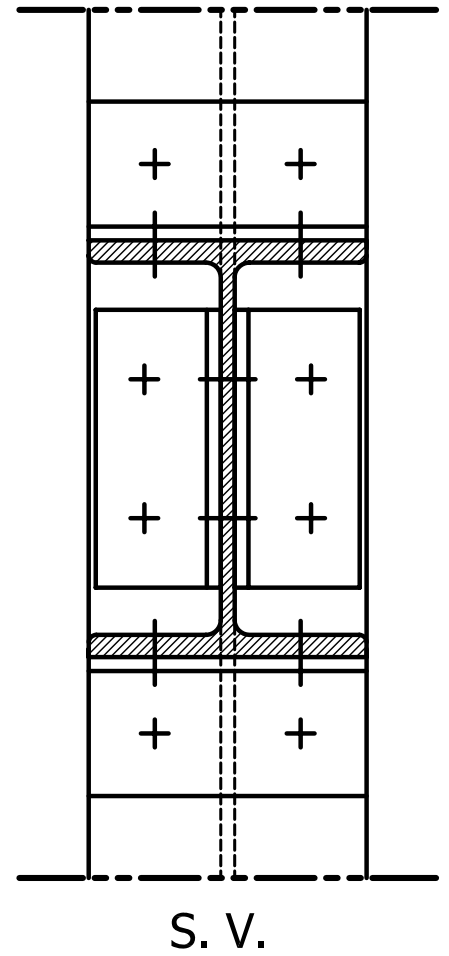
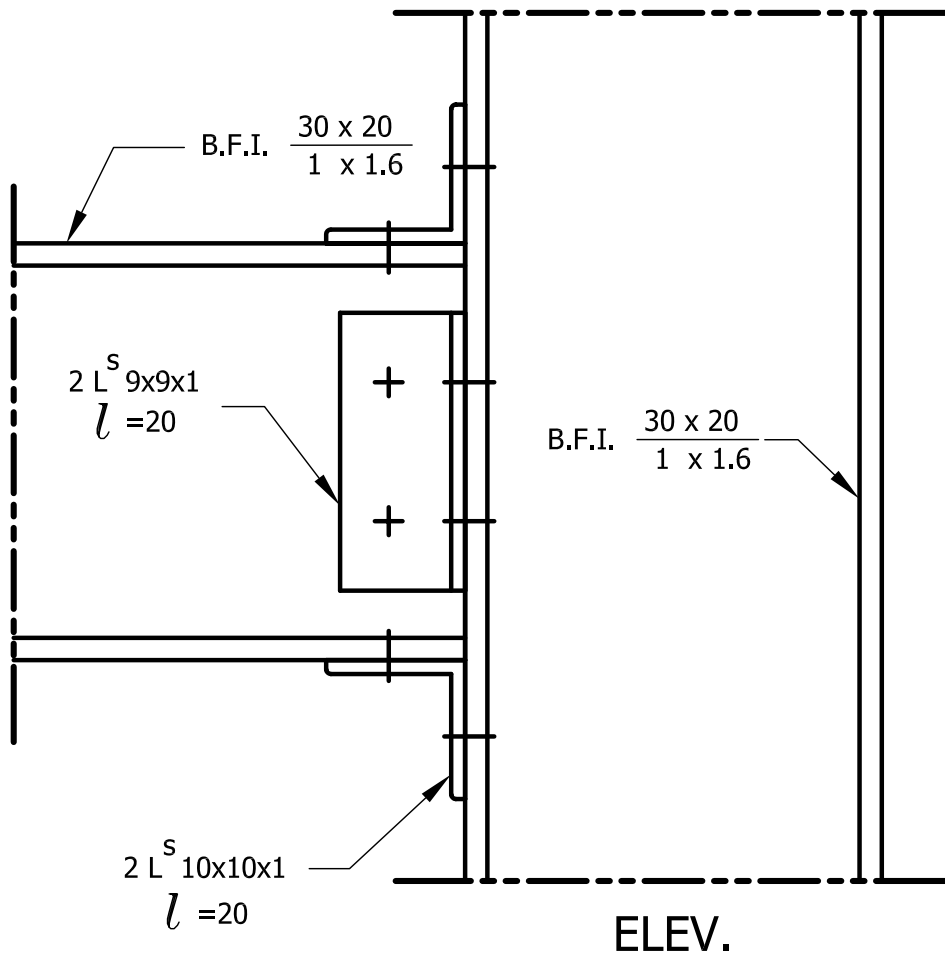
ELEVATION

SIDE VIEW

Draw the SIDE VIEW of the given steel joint.

DIMS. IN CM.

SCALE 1:5



Draw

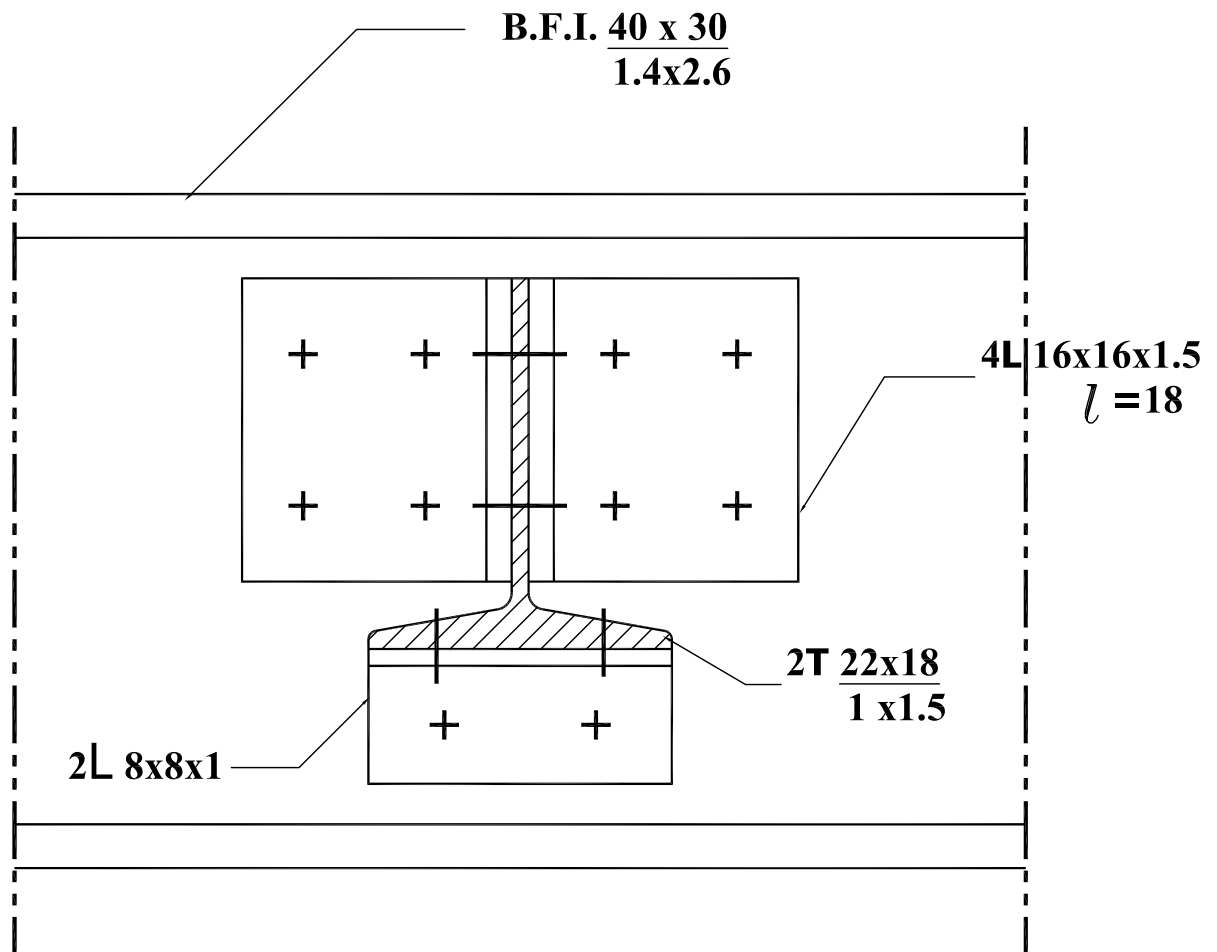
1- Elevation

2- Side View

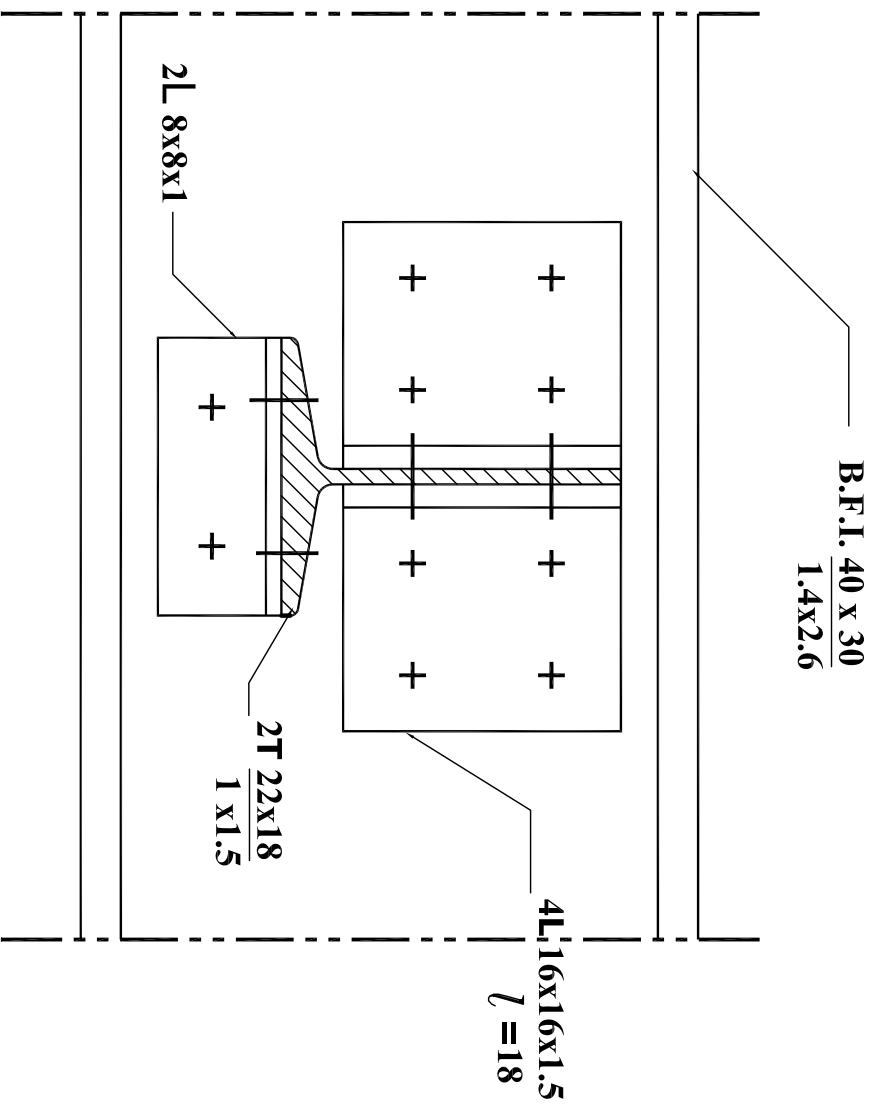
for the following steel joint.

DIMS. IN CMS.

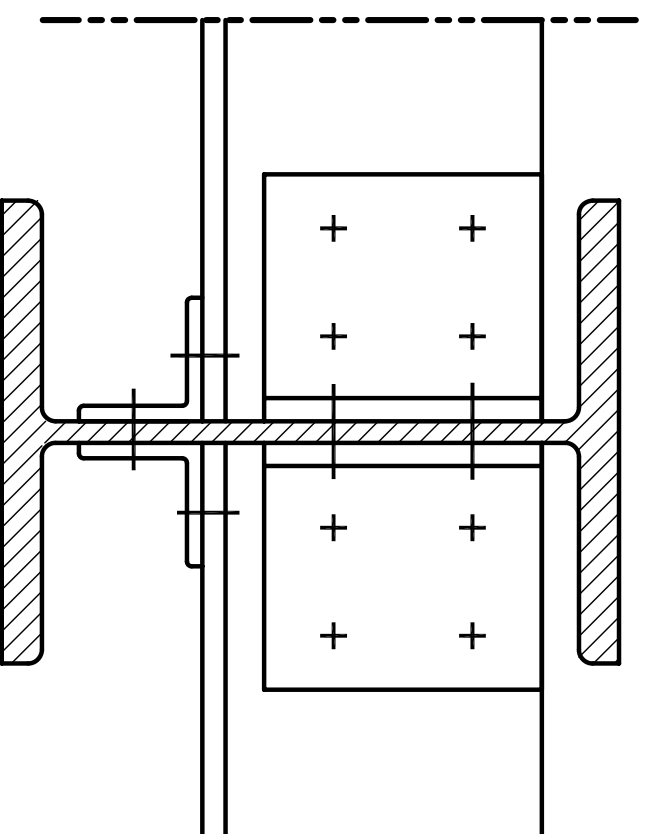
SCALE 1:5



ELEVATION



ELEVATION



SIDE VIEW

Draw

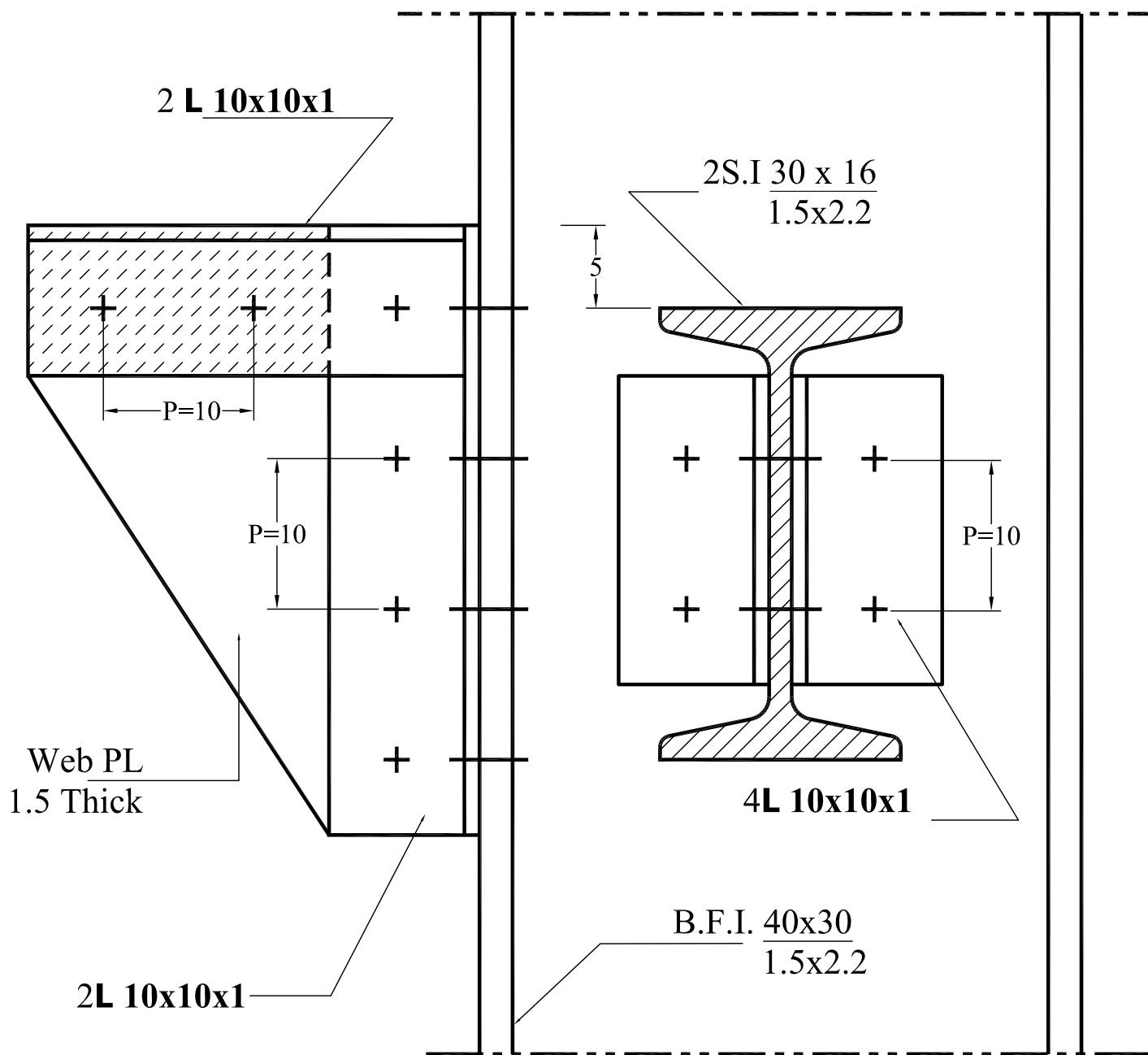
1- Elevation

2- Side View

for the following steel joint.

DIMS. IN CMS.

SCALE 1:5



Elevation



Draw

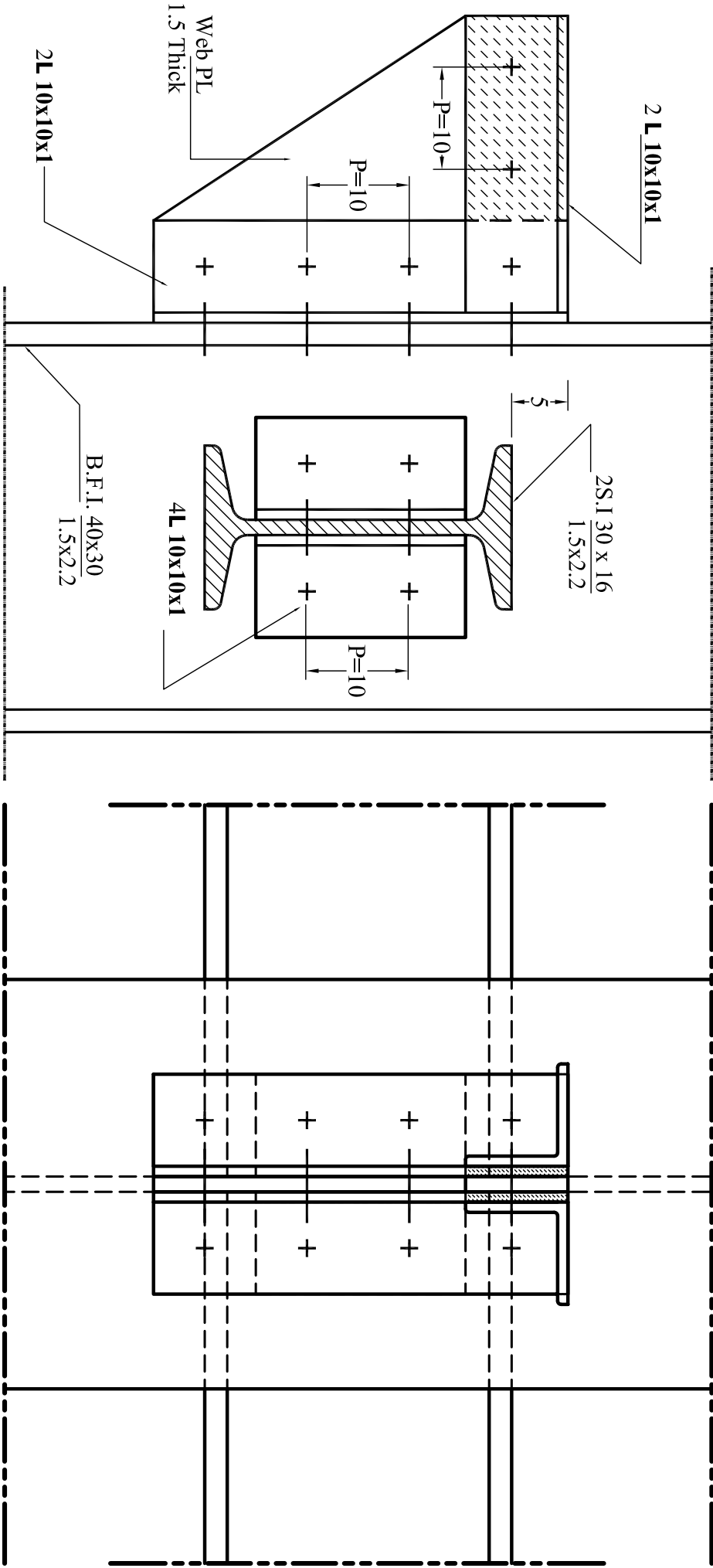
1- Elevation

2- Side View

for the following steel joint.

DIMS. IN CMS.

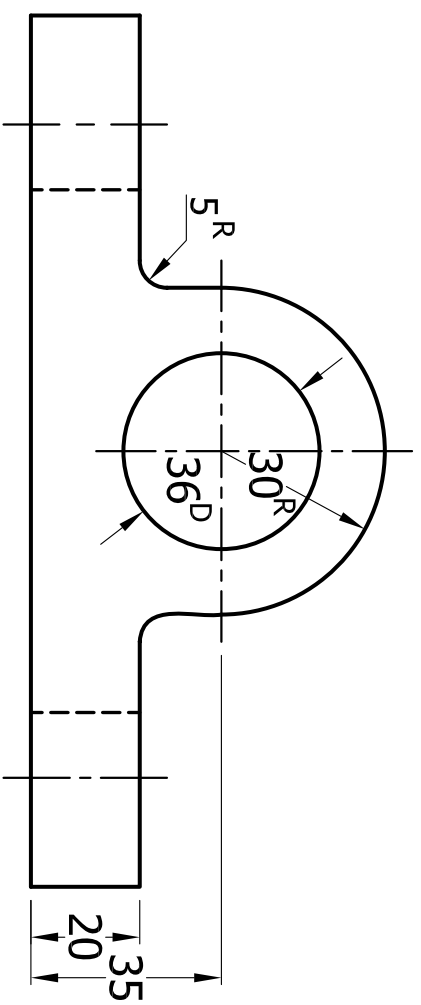
SCALE 1:5



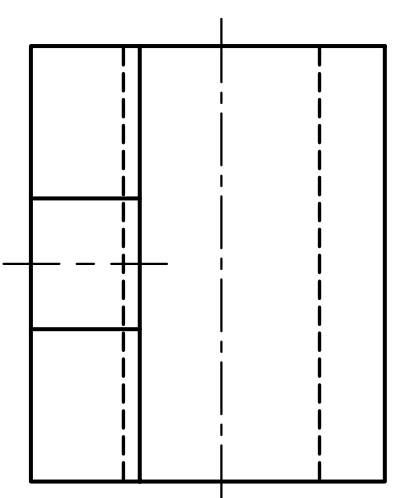
ELEVATION

SIDE VIEW

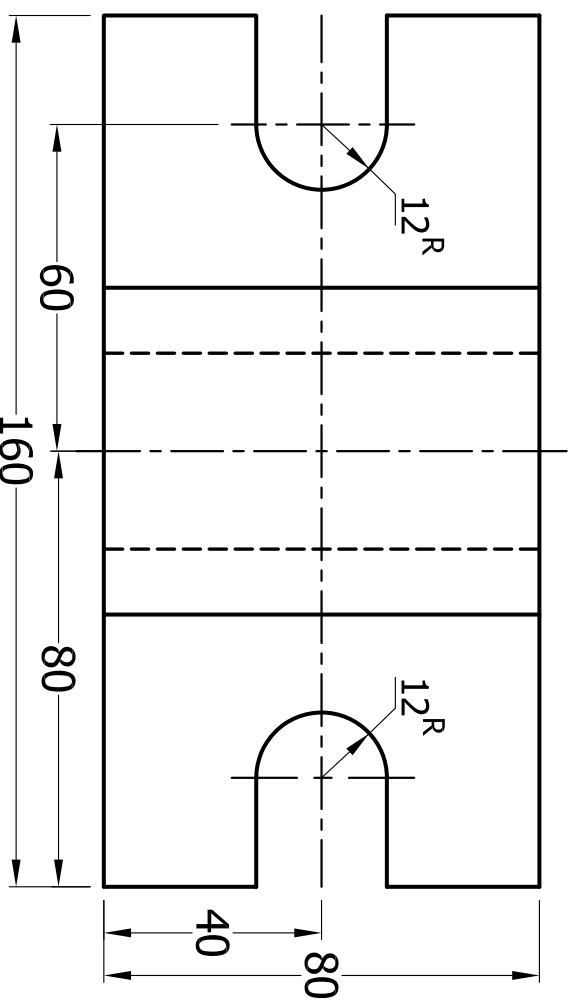




ELEVATION

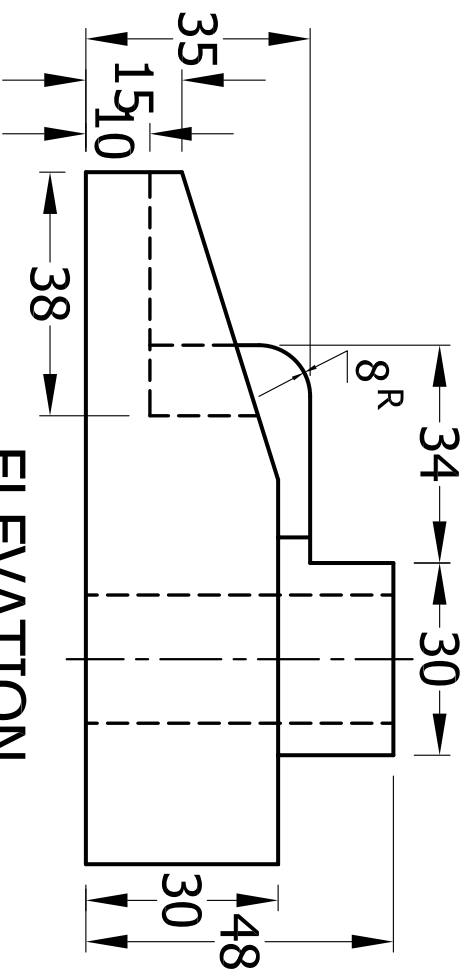


SIDE VIEW

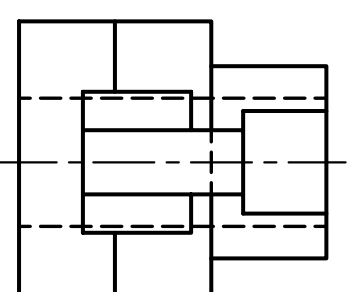


PLAN

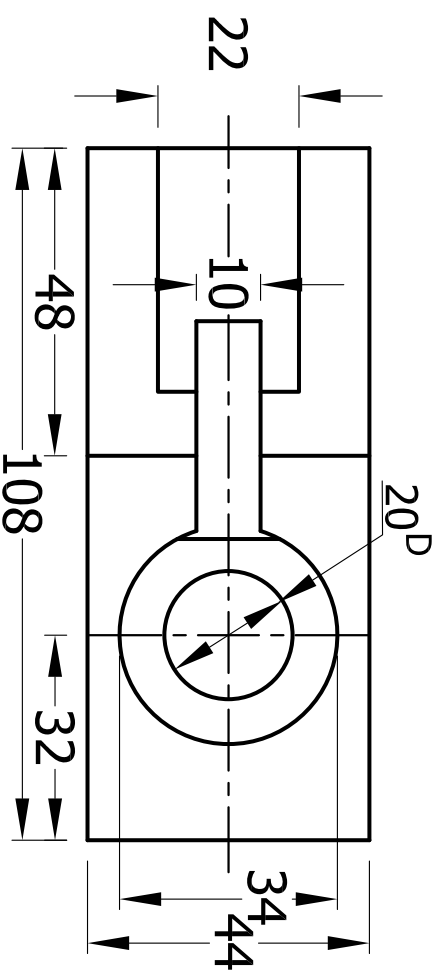




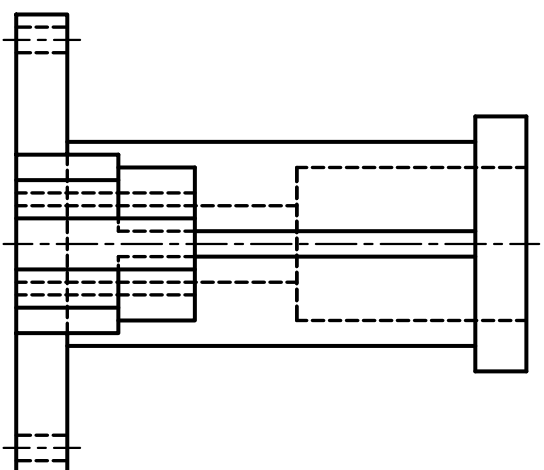
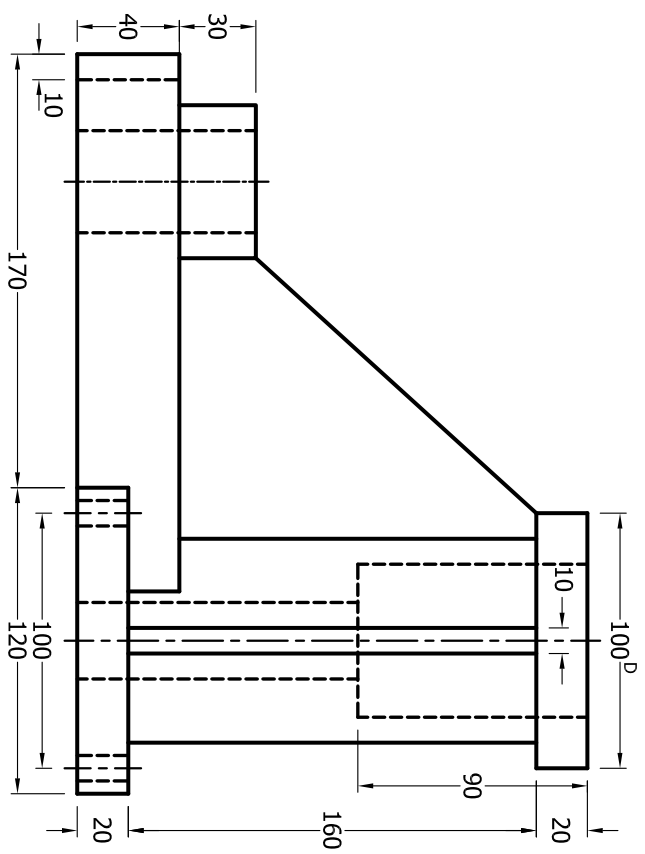
ELEVATION



SIDE VIEW

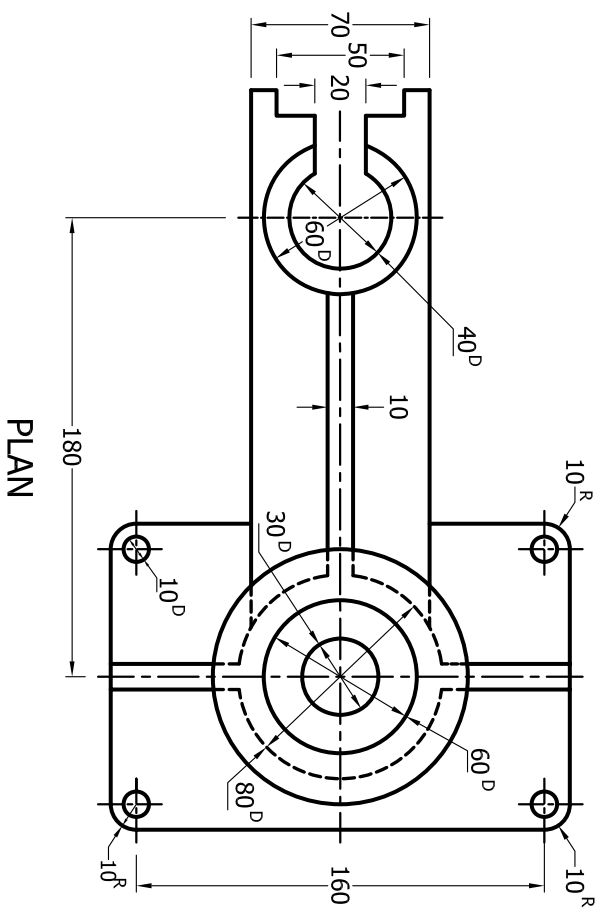


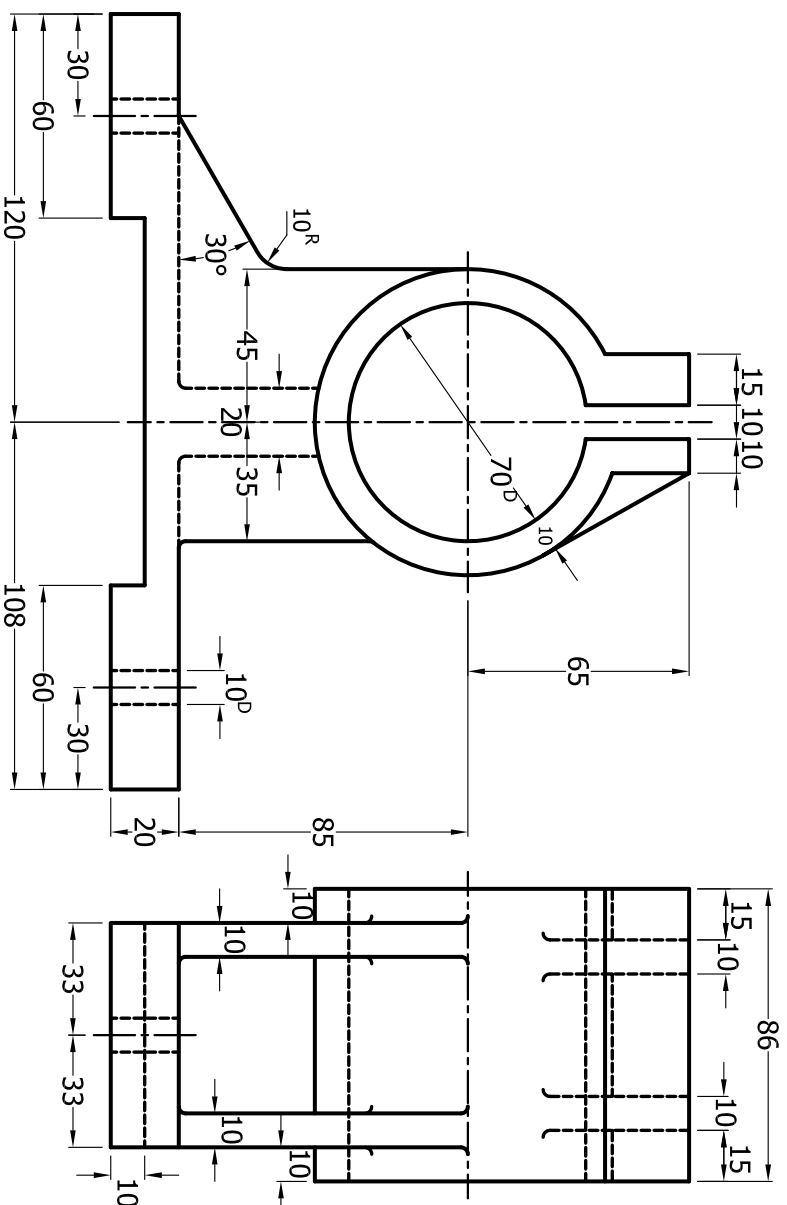
PLAN



## ELEVATION

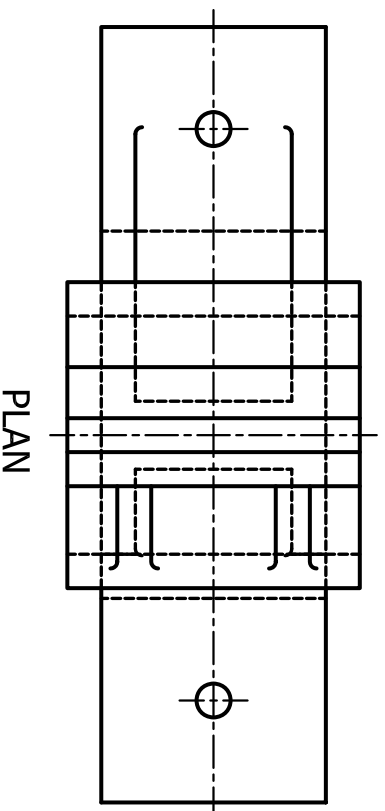
**SIDE VIEW**



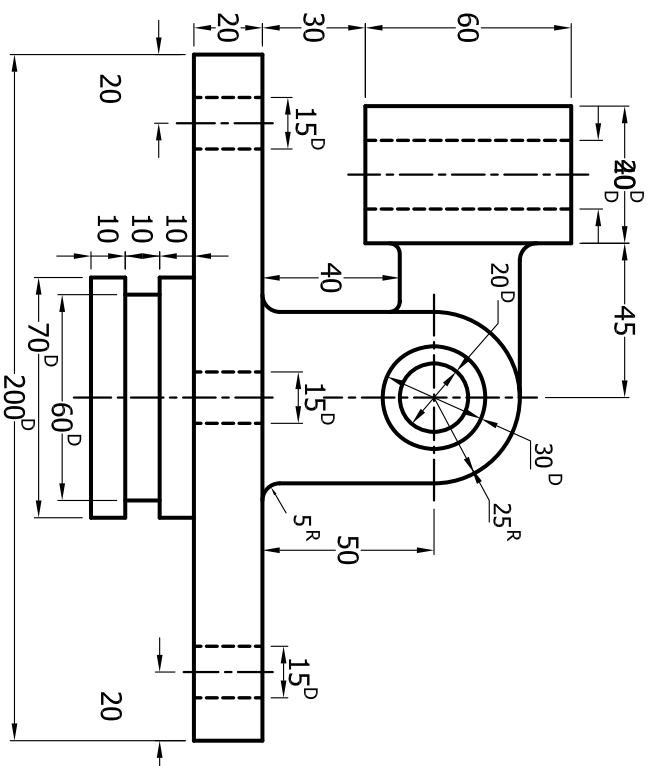


ELEVATION

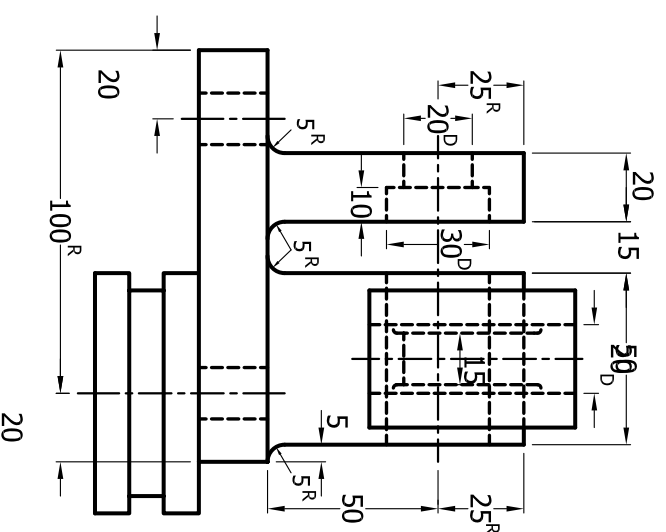
SIDE VIEW



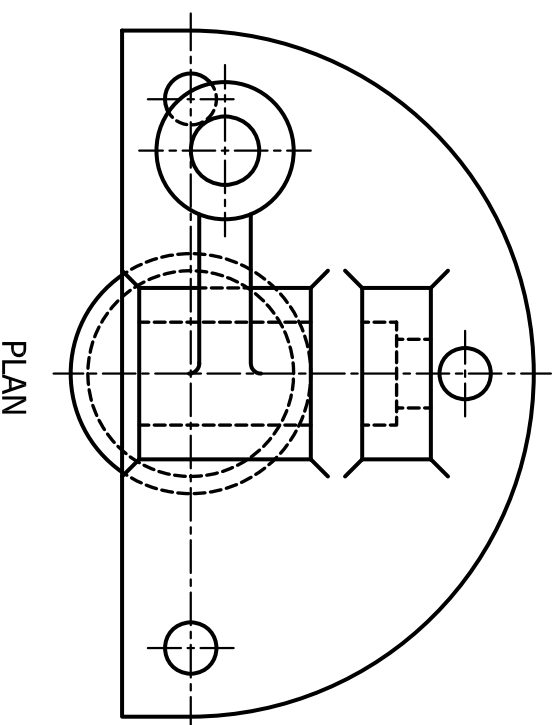
PLAN



ELEVATION

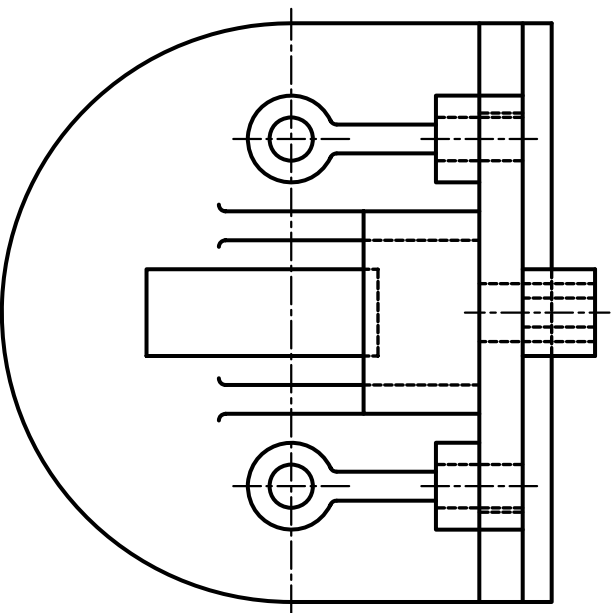
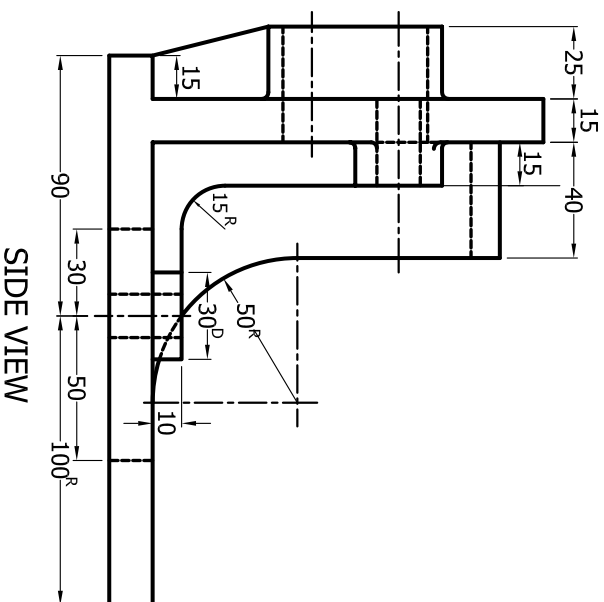
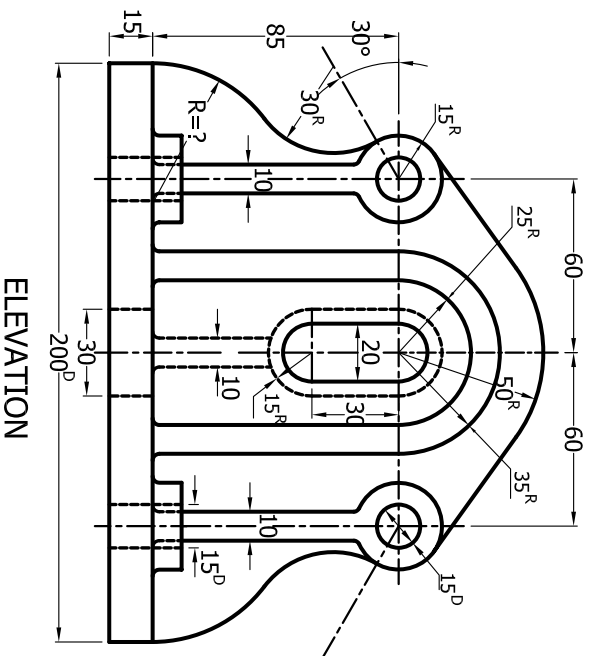


SIDE VIEW

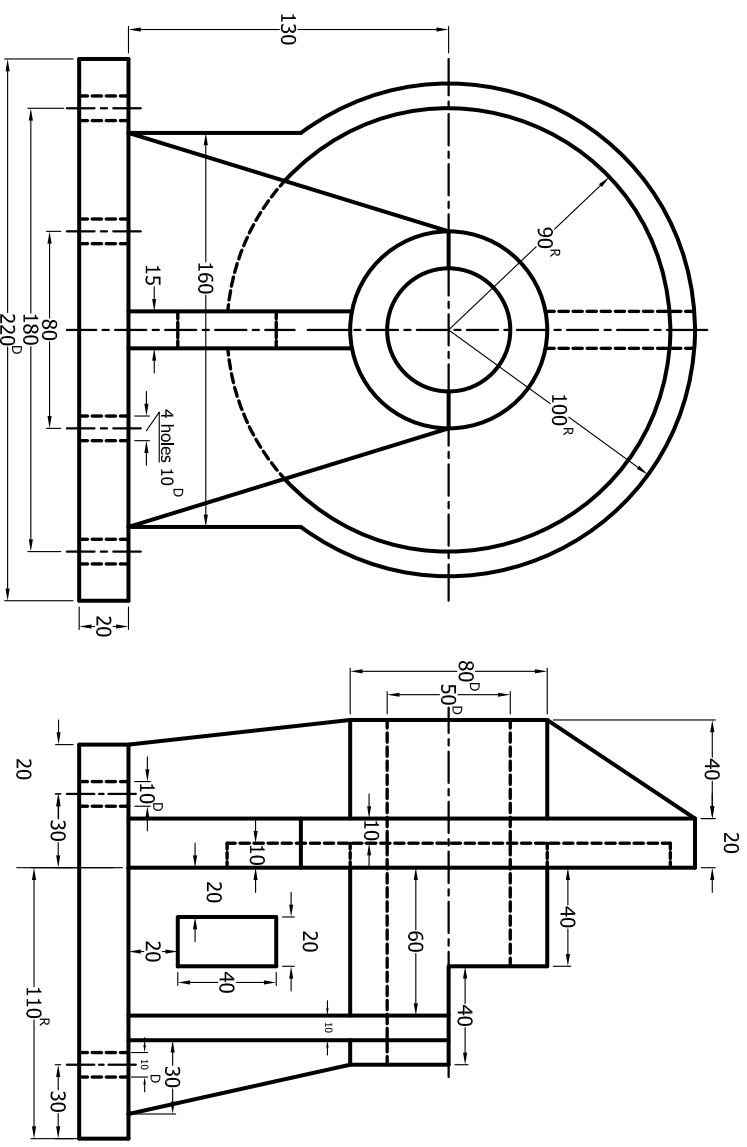


PLAN



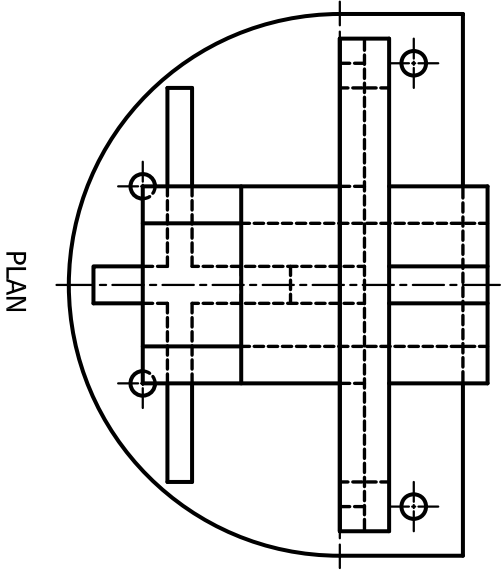


PLAN

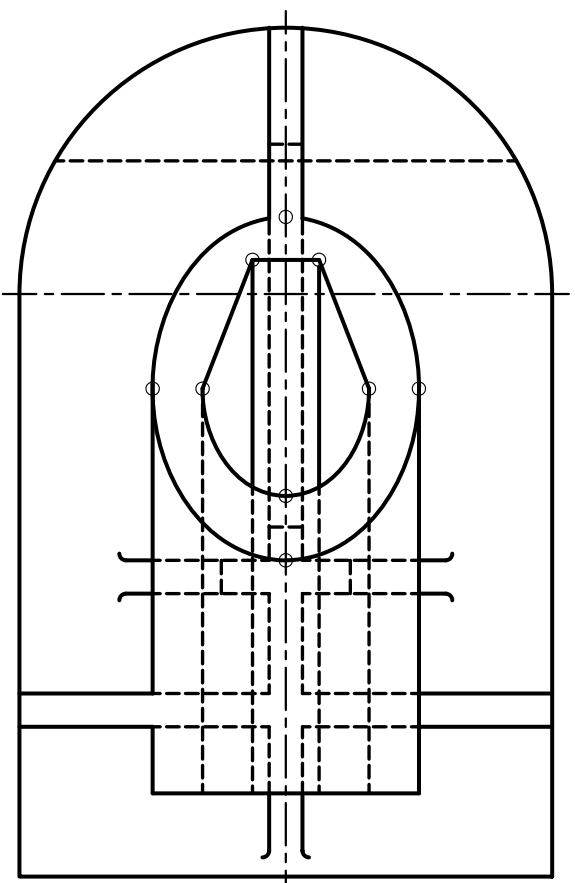
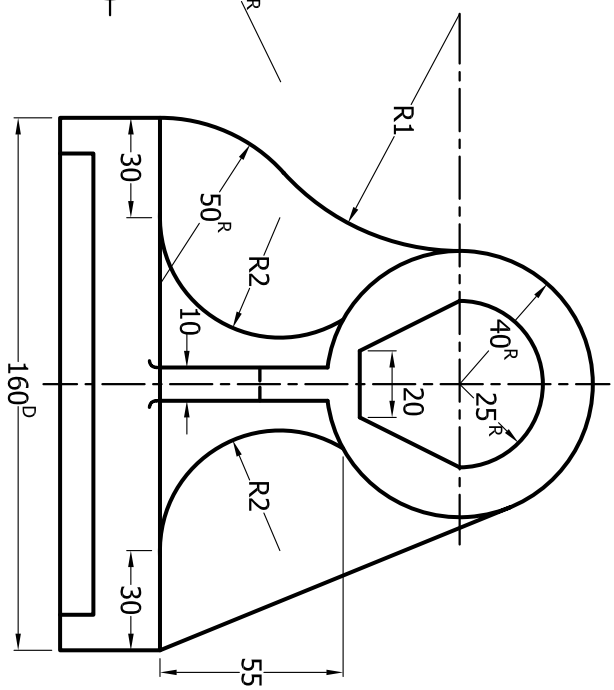
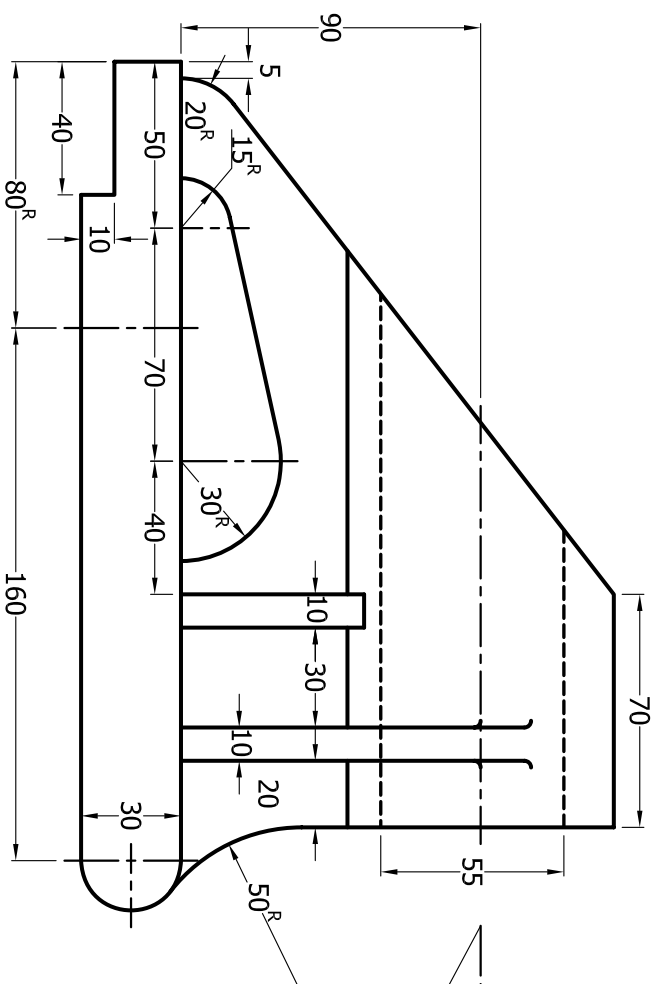


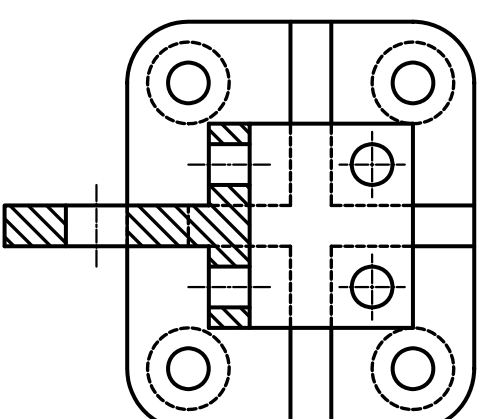
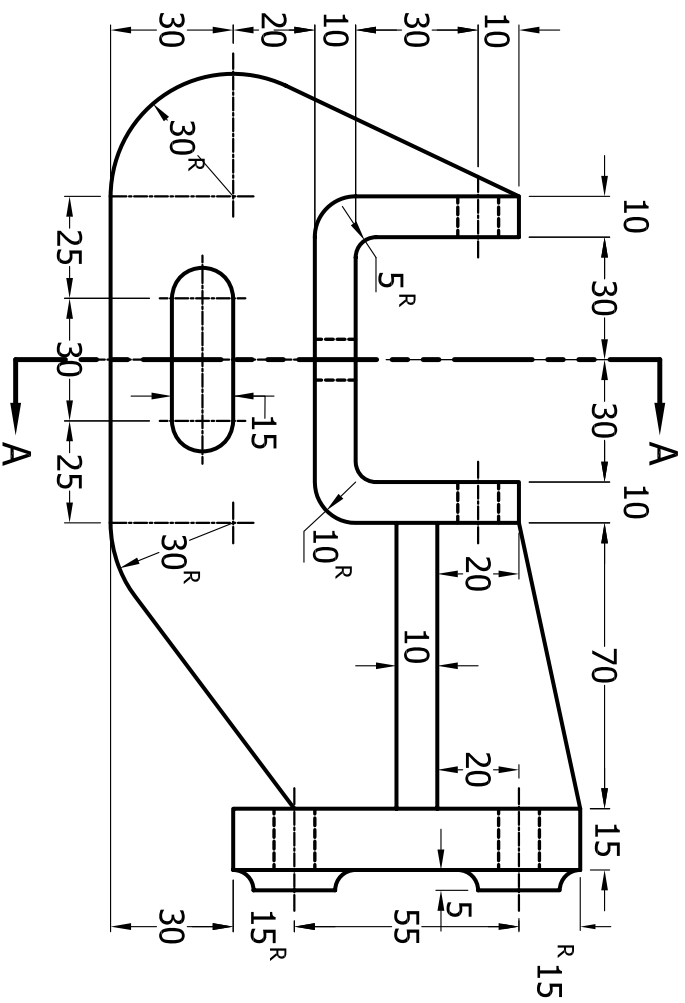
ELEVATION

SIDE VIEW



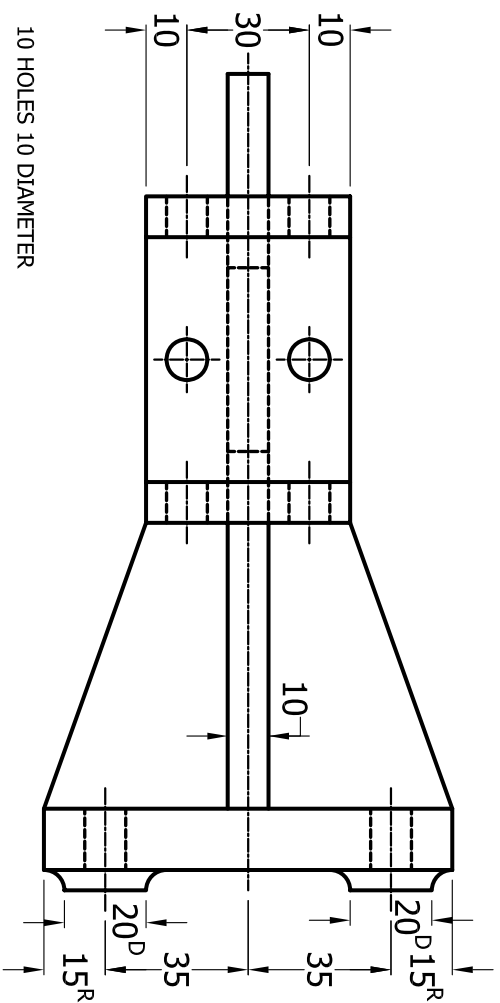
PLAN





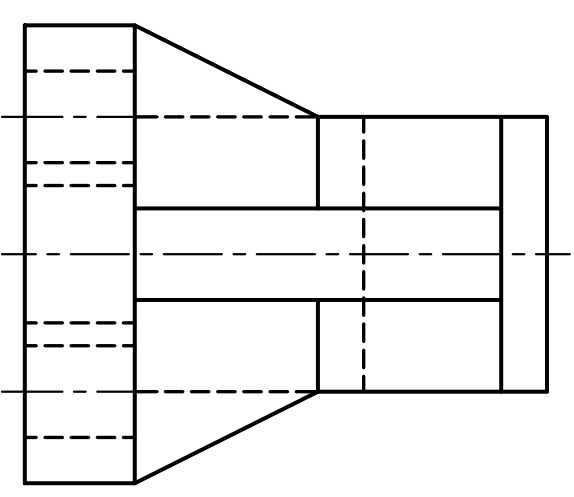
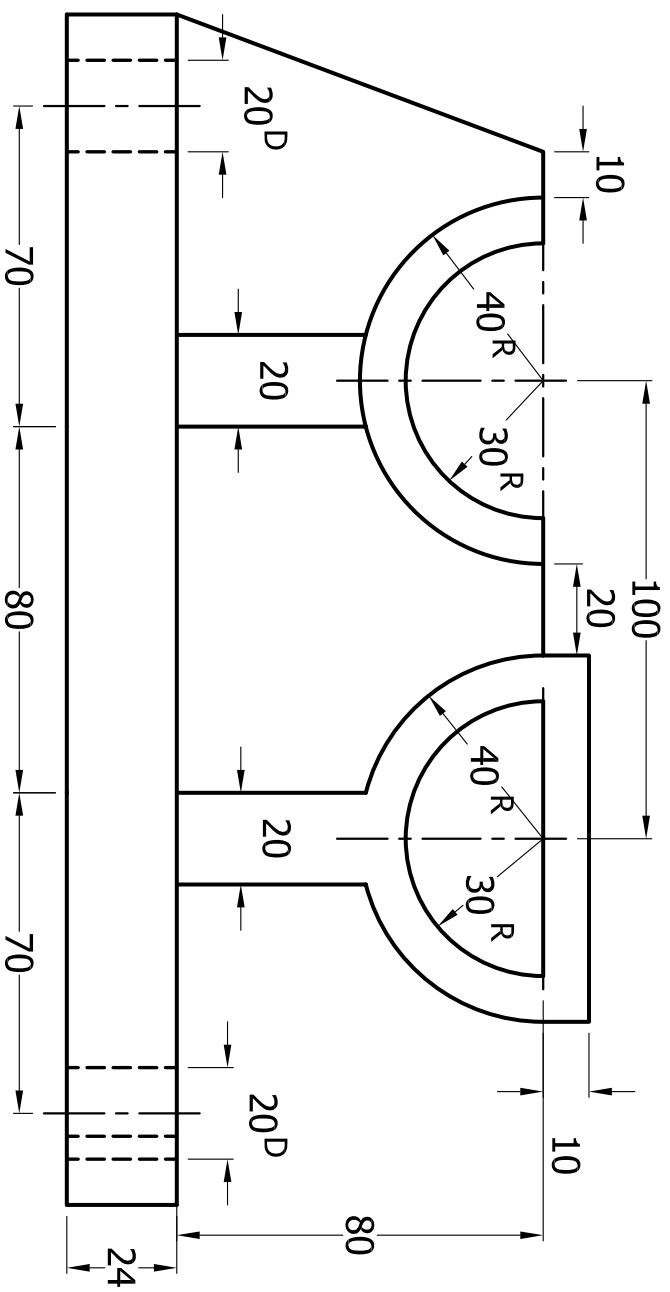
ELEVATION

SEC. SIDE VIEW A-A

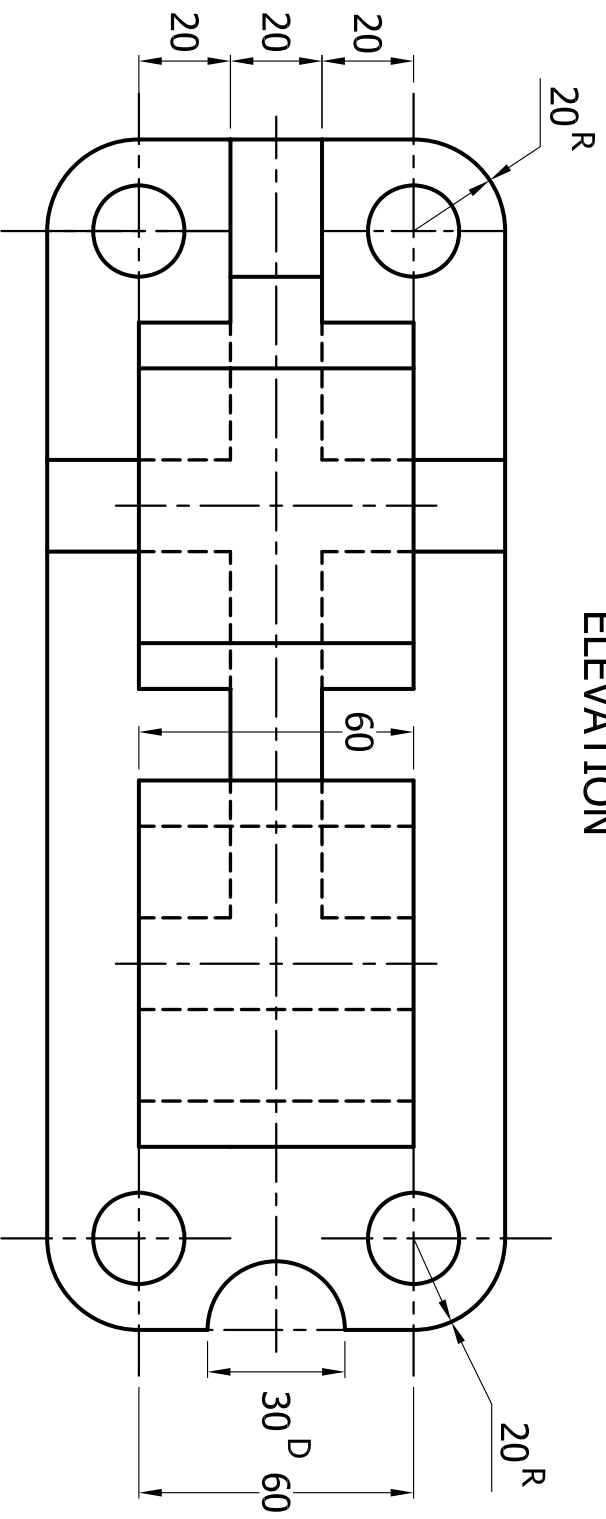


PLAN

10 HOLES 10 DIAMETER



ELEVATION



PLAN



